JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy.

Entered as second-class matter May 7, 1906, at the Post Office at San Francisco, Cal., under the Act of Congress March 3, 1879

VOL. XXII NO. 5 SAN FRANCISCO, JANUARY 30, 1909 PER COPY, 10 CENTS

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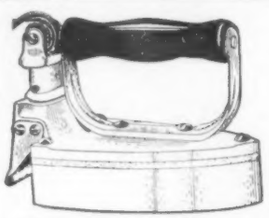

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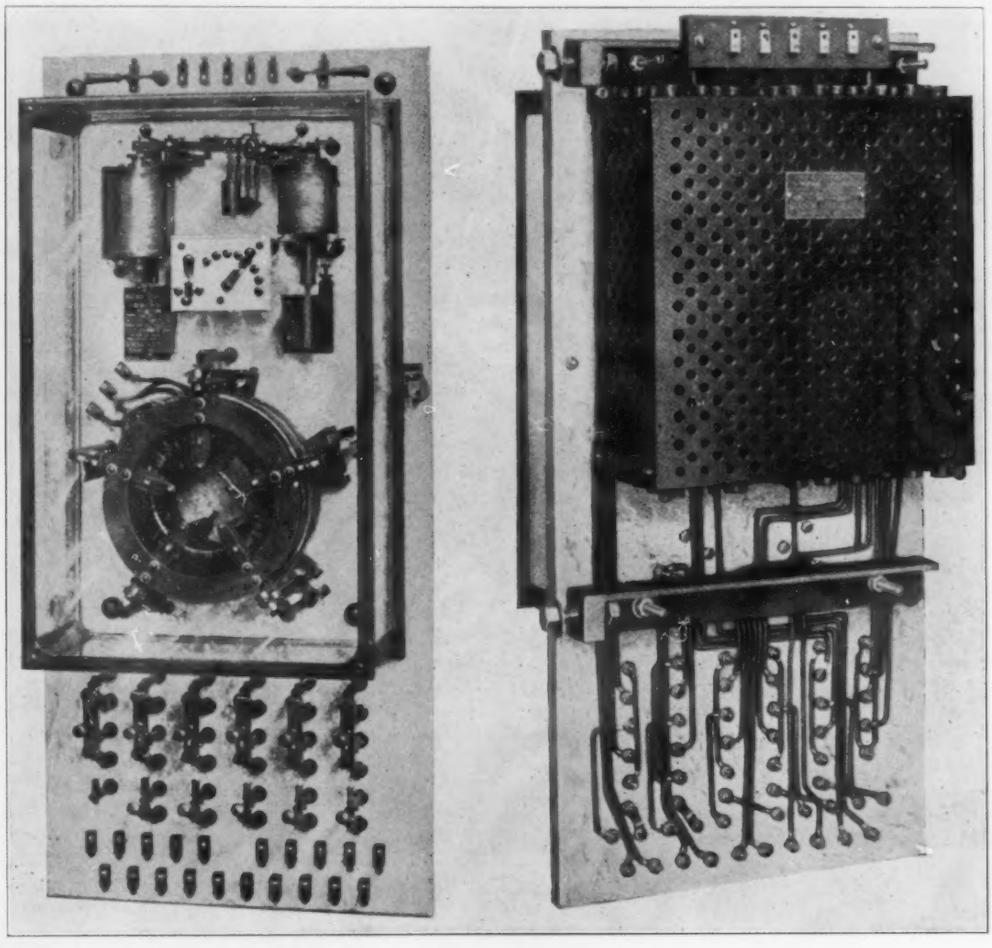
VOLUME XXII. SAN FRANCISCO, JANUARY 30, 1909 NUMBER 5

AUTOMATIC VOLTAGE REGULATION[1]

BY J. A. LIGHTHIPE

I have written this short paper, not to give any new methods of regulation, but rather to take up what we have at our hand and see how far it is advisable to make our systems automatic. I will make a hasty review of what has and what can be done with the main object of promoting a discussion. Most of us realize that one of the best assets that a company can have is continuity of service and constant potential at the distributing plant.



Tirrill Regulator.

In the early days of the three-wire Edison plants, this fact was realized, and the stations were laid out with eight or more feeders, each with a large rheostat in series, and pressure wires run back from the ends of the feeders to the station switchboard. They picked out the heaviest feeder, and pressure wires were run from this feeder terminal to a potential indicator built on the Wheatstone bridge principle, that is an incandescent lamp was on one leg of the bridge and the change in the resistance of the carbon in the lamp, due to changes in voltage, swung the galvonmeter needle to the right or left, showing the voltage high or low. The indicator was sensitive enough to make a change of one volt move the needle an inch. The rest of the feeders were equipped with differential galvonmeters which showed

[1]Paper read at December meeting of the Los Angeles Section of the American Institute of Electrical Engineers.

high or low in comparison with the standard feeder. As the load came on, another pair of dynamos was thrown in multiple with those running, the potential being guessed at by a pilot lamp on top of the dynamo, and a dynamo tender that could throw in another pair of machines without throwing off the belt or bending the ampere-meter needle was an expert and got his diploma. They afterwards bridged the feeder end with heavy copper and did away with the rheostats; then on account of the excessive drop on some of the long feeders, they used an auxiliary bus and somewhat higher potential, and threw the low feeders on it.

During this stage of the art, there were many attempts to automatically raise or lower the potential at the bus bar as the load called for, but most of them worked very restlessly and erratically and were invariably dispensed with after a short trial, going back to the faithful, tireless, sleepless operator.

About this time the single phase, high frequency, alternating current system came out with 1,000 volts, four times the potential, one-sixteenth of the drop; the problem was solved, we did not have any drop and therefore perfect regulation. We found afterwards that there was a drop of about 8% in the transformers that were then made. We also found that we could not run these machines in multiple and had to use double-throw switches to throw the feeders on from one machine to the other. This gave a bad wink and from what I see every night about 10:30, I do not believe that Los Angeles has outgrown the habit. These machines were finally compounded, which helped out the drop considerably.

About this time I ran a series of incandescent lamps for the city lighting, each lamp being bridged by a small compensator. We knew how much current the lamps would take and were informed that the compensator took nothing, and ran into the paradox of our lamp load not jibing with our ampere meter. This was four years before power factor was born. When we started to run our systems by water power there was no governor worthy of the name, and all our regulation was made through the gate. I remember when somebody wired Mr. Mitchell, the Portland representative of the Edison Electric Company, for his opinion of the best water wheel governor, he wired back, "A tachometer and a Chinaman."

With the advent of our polyphase transmission plants, the question of regulation drifted from the power house to the substation. In the Sacramento-Folsom plant, one of the first plants installed, the center of the city was taken care of by a low tension, four wire, three phase, Y neutral system at 200 volts, and the centers of the distribution were taken care of by eight feeders, each with a single phase regulator on each wire of each feeder. The feeders were run very symmetrically on the poles, and pressure wires were run under each wire back to the station and connected to volt meters. The wiring looked fine, but the results were fierce. We got over our difficulty by using three wire cable for pressure wires and transposing our feeders. We still depended upon our tireless operators for good regulation. About this time, we found that three synchronous motors that were installed in the Sacramento substation were a great help to us, we could raise or lower our system with field of the motors, changing our power factor leading or lagging. As our substation grew larger and more complicated, various means of regulation were adopted. Taps on our transformers, compensators, and induction regulators, some singlephase and others polyphase.

With the introduction of the Tirrill regulator, we had a regulator that was almost instantaneous in its action. These were installed in the power plant and by the use of compensated voltmeters we began to get better results. It was automatic. Then we tried to make our synchronous motors regulate automatically. Mr. F. G. Baum devised and installed in the Piedmont substation in Oakland a device connecting the series coil of the exciter around a shunt placed in the main d. c. bus bar. This helped the regulation at the substation but the application was limited. With the Tirrill regulator attached to the synchronous motor we have the means to automatically use the synchronous motor to regulate our potential and by means of a compensated voltmeter keep our potentials at our centers of distribution constant. This placed on our main feeder and automatic motor driven regulators on the other feeders will give almost perfect regulation.

About four years ago I set up an experimental Tirrill regulator in the power house of the Oakland Gas, Light & Heat Company. This regulator was connected with the exciter of a 500 k. w. motor generator set. A Bristol recording voltmeter was installed to watch the effect. After waiting about half an hour without seeing any great change in the excitation, I telephoned the substation of the Standard Electric Company to raise the voltage of the transformer taps until I told them to stop. Inside of 15 seconds the synchronous motor had 100% overload in kilovolt amperes. The operator at the substation then telephoned that either his voltmeter or the switches were out of whack, as he could not raise his potential a volt.

Our feeders should all be provided with quick acting circuit breakers and the main trunks with time-relay cutouts. With long transmission lines I would recommend automatic switches and reverse current relays at the substations. With only two lines the reverse current relay is useless if the short on one line is near the station, as we would have practically zero voltage and both sides are liable to go out. With three lines, you have the two lines to help throw the bad one out. If we are afraid that we cannot build a switch to open 20,000 k. v. a. at 100,000 volts, let us use the switch to bridge an explosive fuse which we can build to break almost unlimited k. v. a. or potential. If we cannot get a switch this year, we will have it next year.

Ten years ago when we built the Santa Ana River plant we used selected switches because it was an impossible problem to devise a switch that would break 33,000 volts and 4,000 kilowatts.

I have brought out these facts to start a discussion, as many of you have had a good deal of experience with both automatic devices and hand operation. I believe that we can operate all our lines automatically better, quicker, safer and more reliably than by hand.

DISCUSSION.

A. S. Glasgow—I feel that the subject of potential regulators is one on which we have given too little thought. This is due probably to our exceedingly rapid growth which has caused us to concern ourselves more with providing a source of current and a means of getting it to a market, than to the refinements of the distributing systems. Of course, every man connected with the operating department of our various lighting companies desires regulators and prefers them automatic, if obtainable. The management, however, is quite liable to consider such devices a luxury, but a little calculation is all that is necessary to change their minds. For instance; suppose we have a lighting feeder circuit on which there is a peak load of 100 k. w. in incandescent lamps for two hours each evening. Now suppose that the voltage on this current is 7½% low. This means that the power taken by this lamp load is 85.5 k. w. instead of 100 k. w. as it should have been had the potential been normal. In one year this means a loss in gross revenue, at 9c per k. w. per hour of $952.00, or about $400.00 in net revenue. This would nearly cover the cost of the regulator.

R. J. C. Wood—The best regulator we have is copper, plenty of copper, but it is an expensive one. There will come a time in the life of every feeder when no amount of automatic regulation at one end will be sufficient. The voltage may be kept perfect at one point, while at others lamps are either being burned out or giving poor light.

With regard to the Tirrill regulator, I wish Mr. Lighthipe had said more about it. I am afraid of it for long transmission lines. Suppose a short occurs on the line, the Tirrill, not being quite human, thinks it is simply a case of very bad voltage and proceeds at once to build up the generator fields to the limit. The speed of the generator also drops. Now if the short breaks, the voltage instananeously jumps to an abnormally high value. The Tirrill may act quickly enough to prevent the voltmeter

from showing the full extent of the rise, but the rise will be there.

I believe a good regulator for transmission lines should be of the Tirrill type, but have a relay or cut-out that would lower the voltage if it once dropped to, say 50% of normal, the Tirrill to work in the ordinary way from 50% or normal voltage up. We have a Tirrill regulator at Santa Barbara on a mixed light and railroad load, and its operation is all that can be desired. The voltage is held very steady and builds up automatically for the evening peak, the regulator being compounded for this effect.

E. F. Scattergood—The author of the paper expresses his belief that "we can operate all our lines automatically, better, quicker, safer and more reliably than by hand." If I understand the meaning, it is not that we can do this with the apparatus which we have at present, but that in many instances we can, and that with constant effort on the part of engineers and manufacturers, apparatus can be developed to take care of other conditions with equally good success, with which I believe the most of us will agree. Again, if I understand correctly, Mr. Lighthipe's attitude in presenting this paper, is to encourage efforts on the part of engineers in developing automatic apparatus; making their wants known to the manufacturers and demanding apparatus which will successfully take care of them, pointing out the defects and demanding that they be remedied. Certainly his past work would indicate that he at least will do his share of such pioneer work or development and would gladly have others do theirs, which we should do.

The two general forms of automatic apparatus which have been referred to are circuit breakers for disconnecting feeders or portions of a system in trouble for the protection of the whole, and apparatus intended to control the voltage on different feeders or different portions of such an electric system.

It is the function of the engineer to determine in each case, what automatic apparatus is called for and desirable, adapting that already on the market, if at all suitable, and striving to vary it or attempt something entirely new if conditions justify or require it, and rather than attempt to go into details or particular instances or particular makes of apparatus, I would rather be permitted to attempt to picture before the meeting, an expensive electric system similar to those in this section, consisting of numerous sub-stations or secondary distributing points in various parts of the larger cities and in various surrounding cities and towns; main distributing points, with auxiliary steam plants in connection therewith, and hydro-electric power plants located at distant points. Speaking first of automatic circuit breakers of the fuse or switch type, as the case may require, but probably entirely of the air or oil switch type, we would have at such sub-stations feeders controlled by automatic breakers. It would seem without question, lines or feeders from the main distributing points to such sub-stations or similar high tension lines from sub-station to sub-station, in many instances, should be controlled by automatic breakers, but preferably in most instances with a time element. This especially applies in case two or more sub-stations are connected on the same feeder from the central distributing point.

A complicated high tension electric system, be-sprinkled with automatic breakers, without the quieting effect of the time element judiciously applied, is suggestive of nerves to say the least, and more interruptions to service and high insulation strains may be experienced than without any automatic feature.

Just a suggestion or two in regard to voltage regulation. At substations referred to or at entirely independent but small generating plants, low tension feeder regulators are essential to good service in lighting covering any considerable area and often a desirable addition to a power feeder. Successful automatic regulation has been attained for these conditions and it rests with the engineer to say whether circumstances justify it in each instance.

In connection with the regulation of the system as a whole from the central distributing point, we should keep in mind the importance of striving to keep the current on the various transmission and high tension distributing lines as low as possible, approaching unity power factor as nearly as it is practicable. There is no question that considerably more energy is being lost in such lines, "as air cooled copper rheostats" than we sometimes realize. This is especially true of the long distance transmission lines from the hydro-electric plants and can be cared for very nicely in connection with the generators at the auxiliary steam plants in conjunction with synchronous motors where such are desirable both at the main distributing points and at sub-stations.

In the purchase of generators at auxilliary steam plants it would suggest itself therefore, that they have k. v. a. capacity in excess for this purpose. Synchronous motors are not desirable in too small units and not desirable except where an attendant would otherwise be required, but in large units and with attendants necessarily present, they will help out a great deal. The tendency towards induction motors on the part of users of power is, I believe, more fortunate than otherwise as giving more satisfactory service and less trouble to the power company.

The auxilliary steam plant and large synchronous motors can be depended upon to take care of this power factor very well and assist in regulating the bus voltage at the main distributing points, as well as at such sub-stations as have them.

The power factor on the long distance transmission lines being thus raised to practically unity, automatic voltage regulators placed at the distant power house are without doubt very desirable and can be set to regulate the voltage to compensate for line drop and for as much more as may be desired, these regulators being very satisfactory in their operation as at present on the market.

J. A. Lighthipe—At the Edison Electric plant we float a 2,000 k. w. steam driven turbine unit over the peak to help out the power factor and this greatly improves our regulation.

H. Wiatt—The question of how far automatic regulation can be carried on our electric system, is one which opens up a wide field for speculation. If the conditions considered could be held stationery for a time, and allow the matter of regulation to catch up, as it were, it would be possible to make a better showing, but this would not be progress. All the details of electrical production have been, and are being so refined and improved that as progress is made with regulation, the requirements become more exacting. Much more is being accomplished in the matter of regulation today, than was even attempted at the beginning of things, of which Mr. Lighthipe has written in his paper under discussion, and yet regulation is comparatively as far from perfection today as at that time. It is probably generally conceded that automatic would be preferable to hand regulation. Although much has been accomplished in this line to date, the performance of automatic regulators leaves much to be desired, and also leaves much to be performed by the tireless, sleepless, more or less reliable attendant, to whom Mr. Lighthipe refers, and must still at times come on the scene to save the day, as of yore. Considering the ordinary commercial system, composed of an extensive field of small consumers, the demands of each varying from the other in particulars which makes their regulation impossible to handle from any one point, the subject of regulation becomes an extremely complicated one. The subdivision of such a system into as many circuits as practicable, with a potential regulator, on each circuit, reduces the extent or rather the range of variation in drop, and is a long stride toward the desired end; and yet these individual circuits are still hampered by their varying local conditions, which are as yet unprovided for. As to how far automatic regulation can be carried, this is realized to be a question impossible at this time to answer. However, the progress and success of automatic regulation to date justifies great hopes for the not far distant future.

V. L. Benedict—The Tirrill regulator is the simplest and most effective generator regulator yet developed. It has three magnets, one of which is across the exciter voltage; another is across the a. c. voltage through a potential transformer, with also

an accumulative wound coil which is in series with the a. c. line through a current transformer. These two magnets act on plungers, the other ends of the pivoted levers making floating contact with each other. This contact closes or opens one of the differentially wound coils of the relay magnets, both of which coils are across the exciter voltage, one being connected permanently.. When one coil is opened, the other overpowers a spring and breaks the contacts of a short circuit across the exciter field rheostat. Thus, if the a. c. voltage is too low the floating contact closes, demagnetizing the relay magnet, and the spring that closes the contact, and the exciter rheostat being short-circuited, boosts the exciter voltage. This regulator may be applied to any generator or to any exciter. It is preferable, however, to have low densities in the iron of the exciter so that the shunt field current will not increase more than about 30% when the exciter voltage increases from 125 to 150.

By varying taps on the current transformer, the regulator can be adjusted to maintain constant potential at a desired distant point in the distributing system at any power factor or load. The regulator may have its current transformer placed in one of a group of feeders; thus, a feeder regulator for that circuit is not needed. If some feeders should need 5% compensation and some 10% the Tirrill regulator may be adjusted for 5% and the few feeder regulators required may be one-half the size required if no Tirrill regulator were used. This regulator can be used up to 12 small exciters, or a fewer number of large exciters. On these large machines the field rheostat is divided into sections and each section is short-circuited by a relay contact. If a Tirrill regulator be used with a synchronous motor solely for regulating the power factor of a distributing system, the power factor at one-half load should be unity, the motor taking lagging current at lower loads and leading current at higher loads, the adjustment being to take full amperes lagging at no load and full amperes leading at full load on the system.

The motor should have a short circuit current as a generator of at least three times full load current, in order, with 100% change of excitation to be used at full load current leading or lagging.

The Tirrill regulator with its automatic variation of the exciter voltage, gives the ideal method of applying a synchronous motor as a power factor regulator, at the receiving end of a transmission line. This point is being more carefully considered by operating engineers, than heretofore and has been brought out by the discussion very forcibly. The additional cost of a synchronous motor over an induction motor is well worth the difference in view of the additional generator capacity made available by increasing the power factor. This is extremely important on systems which are short of power.

If only 5% of the full load current is available for regulation of the power factor, this would mean 95 k. w. output and 31 leading k. v. a.'s for correction of power factor with normal heating at full load output. The most economical point to use the synchronous motor for energy output and phase control at the same time, is 71% output energy and 71% wattless current, heating being that at full load current.

Wooden insulator pins for telegraph and telephone use are in little demand. Eucalyptus pins made by a manufacturer at San Jose, are of a special type soaked in parafine and used for power purposes only. The demand and production are limited. There is a strong objection to eucalyptus pins for standard work owing to the brittleness of the material and its liability to break under considerable strain. It is also an expensive wood to work in manufacture, owing to its hardness. The majorty of the pins used upon the Pacific Coast are of locust, 1½ inches in diameter and 9 inches long. All of these are made in the East, and cost about $16.00 per thousand. Seconds and culls can be bought for about $2.00 per thousand less. These pins are manufactured in the locust region in the East by the million and as the field for their sale on the Coast is limited, it is doubtful whether any local manufacturer can compete.

WATER HAMMER IN PIPE LINES.

By S. L. Berry.

The question of water hammer in pipe lines is a very interesting and important one, and it is desirable that we have as clear and accurate notions of it as possible. That formulae which neglect the compressibility of water lead to erroneous results can be understood by the statement that instantaneous stoppage of flow in a perfectly incompressible fluid confined in a perfectly rigid vessel would give an infinite pressure. That is the limit in one direction, while in the other we find that either complete compressibility of the fluid or complete elasticity of the vessel would prevent any hammer action at all.

Neither limit exists in the problem under consideration and we will find the actual conditions and results somewhere between them. A formula considering only the compressibility of water is used, and is the simplest of any proposed, but the results are too high, and a related assumption gives erroneous results when used in connection with slow closing of the valve.

On the other hand, a formula which considers only the pipe dilation ignores the well known fact of the compression of water and gives results higher than those found by experiment. The primary investigations of this subject were made by N. Joukovsky in 1897, at Moscow, preliminary to the installation of extensive water works. An account of these was presented by O. Simin at the 1904 meeting of the American Water Works Association and published in the Proceedings for that year.

These experiments are so important and far-reaching in their results that they should be studied by every engineer interested in a clear understanding of the subject.

The decrease in volume of water due to an increase of pressure of one atmosphere as given by Grassi (see Gibson's Hydraulics and its Applications) increases from 0.000040 to 0.000051 as the temperature decreases from 212° F. to 35° F. This gives a bulk modulus varying from 368,000 to 288,000 lbs. per sq. in., the value at 50° F. being approximately 300,000 lbs. per sq. in.

These are the figures for pure water, and will be used in the following examples, although the presence of air in solution increases the compressibility and would reduce the resulting pressure. The amount of pressure above normal due to stoppage of flow is so related to the velocity of the pressure wave that it is necessary to know something about this.

The velocity of sound waves in any medium depends upon the elasticity and density of the medium. According to the formula given by I. P. Church;

$$C = \sqrt{\frac{E\,g}{\gamma}} \qquad (1)$$

the temperature remaining constant. In the case of water,

$E = 300{,}000$ lbs. per sq. in.

$g = 386.4$ inch seconds.

$\gamma = 0.03604$ lbs. cu. in. (wt. of water).

$C =$ velocity of pressure wave in inches per second.

and we would have a velocity of 56713 inches per second or 4726 feet per second. This result is variously given and depends upon the temperature which may happen to be considered the average one, and would represent the condition in a rigid pipe line.

What happens on instantaneous stoppage in a rigid pipe is given by Gibson to be as follows: rise of pressure above normal and zero velocity at lower end; a wave of pressure and zero velocity starts from lower end and travels to upper end at a velocty of 4726 feet per second; the compressed column immediately commences to re-expand on arrival of the wave at the top, the pressure drops to normal at that point and a wave of normal pressure and velocity ($-v$ up the pipe) travels to the lower end; on reaching the lower end it is reflected as a wave of negative pressure (below normal) and zero velocity, to be again reflected at the top as a wave of normal pressure and velocity (v) in which v is the original velocity of the water.

This cycle is repeated until the motion dies out, due to a combination of causes.

It will be seen that the increase in pressure is equal in all parts of the pipe, and that the only influence exerted by the length of the pipe is in fixing the time occupied by the wave of pressure in traversing the line.

The persistency of the high pressure at the lower end in seconds

$$= \frac{\text{length of pipe x 2}}{4726}$$

and at any point on the line will be equal to the time required by the wave to travel from the point to the top end and return.

The time for a complete cycle

$$= \frac{\text{length of pipe x 4}}{4726}$$

The time element is important, as any time required to close the valve which is equal to or less than

$$\frac{\text{length of pipe x 2}}{4726}$$

gives the same effect as instantaneous closing.

This is the reason why long pipe lines are more difficult to protect than short ones, and not because they contain a greater weight of water.

The formula for pressure produced in a pipe by stoppage within the limits given and not considering elasticity of the pipe walls is

$$p = v\sqrt{\frac{E\gamma}{g}} \qquad (2)$$

in which

p = pressure in lbs. per sq. in.
E = Bulk modulus of water = 300,000 lbs. sq. in.
γ = 0.03604 lbs. cubic inch (wt. of water).
g = 386.4 for inch seconds.
v = velocity of the water in inches per second.

This reduces to

$p = 5.29\ v$ (inch seconds),

or for velocities expressed in feet per second

$p = 63.48\ v$ (foot seconds). (3)

This is a simple formula but gives higher results than when elasticity of the pipe walls is considered, and the formula above for velocity of the pressure wave gives a shorter time within which the results are the same as for instantaneous closing.

That the velocity of sound in a compressible medium contained in an elastic pipe is less than for a rigid pipe was first proven by Korteveg in 1878, was confirmed by calculation and experiment by Joukovsky, and is accepted as having an important influence on results obtained.

Church's formula for the velocity of the prsesure wave considering the compressibility of water and the elasticity of the pipe walls is

$$C^1 = \sqrt{\frac{g}{\gamma}\cdot\frac{E\,E^1\,t}{t\,E^1 + 2\,r\,E}} \qquad (4)$$

in which

C^1 = velocity of pressure wave in inches per second considering elasticity of walls.
g = 386.4 (inch second).
γ = 0.03604 lbs. cu. in. (wt. of water).
E = Bulk modulus of water = 300,000 lbs. sq. in.
E^1 = Modulus of elasticity of material of pipe walls.
= 30,000,000 lbs. sq. in. for steel.
= 25,000,000 lbs. sq. in. for cast iron.
t = thickness of pipe wall in inches.
r = radius of pipe in inches.

Using the same notation and making v the velocity of the water at the time of closing, the pressure in lbs. per square inch.

$$p = v\left(\sqrt{\frac{\gamma\,E\,E^1\,t}{g\,(t\,E^1 + 2\,r\,E)}}\right) \qquad (5)$$

also when the velocity of pressure wave is calculated as above.

$$p = v\,\frac{C^1\,\gamma}{g} \qquad (6)$$

These formulae give a smaller value for the velocity of the pressure wave, consequently a longer time of valve closing within which the results are the same as for instantaneous closing, and a considerably lower pressure above normal, and they should be used in all cases where the best results are desired.

Any condition tending to increase the elasticity of the containing walls, as for instance, making them thinner, and providing air chambers, tends to decrease the maximum pressure, but lengthens the period of vibration. The latter may produce evil effects in governing in some instances, and is somewhat analogous to increased length of pipe, except that lower pressures are met with.

It is evident, considering a pipe line of any length, that no influence tending to check the flow at the upper end can exist until the arrival there of the wave of pressure and zero velocity; consequently the section at that point will continue to flow after closure at lower end for a time in seconds

$S = \frac{L}{C^1}$ in which

L = length of pipe in feet.
C^1 = velocity of pressure wave in feet as calculated above.
S = time in seconds.

The time S multiplied by v, the velocity in feet per second of the water, gives the distance in feet traveled by the upper section in this time, which multiplied by the area in square feet of the pipe gives the volume in cubic feet which should result from the compression of the water and the stretch of the pipe walls.

Take for example a pipe line as follows:

L = length = 2000 feet.
D = diameter = 16 inches.
A = area = 1.396263401595 sq. ft.
v = velocity of water = 5 feet per second.
A^1 = area of pipe when expanded by pressure p.
p = pressure above normal due to water hammer.
t = thickness of wall = ¼ inch steel.
V = volume of water before compression in cu. ft.
V^1 = volume of water after compression in cu. ft.
S = time in seconds required by pressure wave to reach top end of pipe line.
S^1 = time in seconds of pressure wave for up and down trip.

The head is not material except that it must be taken into account when deciding upon the thickness of the pipe walls.

Then by formula (4) the velocity of the pressure wave

$$C^1 = \sqrt{\frac{386.4}{.03604}\cdot\frac{300{,}000 \times 30{,}000{,}000 \times \frac{1}{4}}{(\frac{1}{4} \times 30{,}000{,}000 + 2 \times 8 \times 300{,}000)}}$$

= 44285 inches per second.
= 3690.4 feet per second.

And the pressure by formula (6)

$$p = 60 \times \frac{44285 \times .03604}{386.4}$$

= 247.83 lbs. per sq. in.

The pressure by formula (3) which does not consider the elasticity of the pipe walls would be 317.4 lbs. per sq. in.

The formula given by Prof. A. Budau which considers the water to be incompressible is

$$(h_o) = \sqrt{h_1^2 + \frac{3\,S}{D}\,\frac{E\,v^2}{\gamma g}} - h_1$$

in which

(h_o) = increase in pressure in feet.
h_1 = operating head in feet.
S = thickness of pipe walls in inches.
D = diameter of pipe in inches.
E = modulus of elasticity of pipe material.
v = velocity of water in inches per second.
γ = 62.408.
g = 32.153.

(This notation is to be used in this formula only and is not to be confused with that given elsewhere.)

Applying this formula to the case above and using the same

value for the coefficient of elasticity of the pipe walls, the excess pressure resulting is 606 lbs. per square inch. As the operating head is included in the formula, this was assumed at 200 feet.

Returning to the previous notation,

$$S^1 = \frac{2 \times 2000}{3690.4} = 1.08388 \text{ sec.}$$

is the time of valve closure which gives the same effect as instantaneous closing. The complete formula for pressure (p^1) due to gradual closing is complicated, but the result can be obtained with sufficient accuracy by the formula

$$p^1 = p \frac{S^1}{Tv} \qquad (8)$$

when Tv is greater than S^1; in which Tv = time of closing of valve in seconds. As noted above, when Tv is equal to or less than S^1 the pressure will be the same as for instantaneous closure.

To show whether formulas (4) and (6) satisfy the condition produced by the flow of the upper section during the time required by the pressure wave to reach the upper end of the pipe, consider the following figures:

The volume of the water in the pipe would be, before compression,

V = A L.
= 1.396263401595 x 2000.
= 2792.526803190 cu ft.

The compression of water per lb. pressure with a bulk modulus of 300,000 lbs. per sq. in. would be $\frac{1}{300,000} = .000003333$

and the compression under a pressure of 247.83 lbs.
= .00082610 which multiplied by V
= 2.306906392 cu. ft., leaving the volume compressed
V^1 = 2790.219896798 cu. ft.

The increased area of the pipe due to expansion can be found by considering the effect of the water hammer pressure on the walls.

The diameter would increase to diameter in inches

$$= 16 + \left(\frac{8 \times 247.827717}{30,000,000} \times \frac{4}{1} \right) \qquad (16)$$

= 16.00422960 inches.
= 1.33368580 feet.

and the area A^1 = 1.39700170 sq. ft.

The length of the expanded pipe occupied by the compressed water will be

$$\frac{V^1}{A^1} = 1997.29169 \text{ feet,}$$

which leaves a distance at the top end of 2.70831 feet which should check with the distance traveled by the upper section, while the pressure wave was traversing the length of the pipe.

The time required by the wave will be

$$\frac{2000}{3690.4} = .54194 \text{ sec.,}$$

and the distance traveled by the upper section = .54194 x 5 = 2.70950 feet, which checks within .00119 feet, or four one-hundredths of one per cent.

In Budau's treatment of the case (considering the water to be incompressible) it is not possible to obtain a correct statement of the velocity of wave propagation, but by calculating the distention of the above pipe, due to the pressure given by his formula, it is possible to find the distance traveled by the upper section of water by comparing the pipe volumes before and after dilation. From this results a value for the velocity of wave propagation which substituted in formula (6) will give a pressure checking closely with that given by formulae (4) and (6). This means, in the case cited, that a pressure of 606 lbs. per square inch is required to satisfy the conditions when compressibility of water is neglected, while 248 lbs. is sufficient when this element is included.

As water positively is compressible, the conclusion is that Budau's formula is incorrect and would lead to results not sustained by experiment. In the above example the simple formula (3) gives a result much closer to the correct one.

THE VALUE OF A WATER POWER.

The value of an undeveloped constant water power is such a sum as when put at a proper rate of interest, say 10 per cent, will pay the difference in cost between steam and water power, items of cost being considered. A power which is variable, and which cannot be depended upon throughout the year, has of course less value than that which is constant. In such a case the items for consideration are: The maximum, minimum, and average quantity of water, and length of time when there is no water; all the other items which enter into the value of a uniform power; necessity in nearly all cases for a supplementary steam plant, with the expense of maintenance and running for a portion or all of the time.

The value of an undeveloped variable power is little or nothing if its variation is great, unless it is to be supplemented by a steam plant. It is of value then only when the cost per horse power for the double plant is less than the cost of steam power under the same conditions as mentioned for a permanent power has been represented.

To determine the market value of such a power which has been developed, it will be necessary to consider the power by itself, independent of the plant; that is, to determine first the value of the power as though it were undeveloped, and then to determine the value of the improvements. The sum of both will represent the value of the power as developed.

It might happen in some cases that the value of the privilege would be a minus quantity, but that the value of the improvements more than offset that, thus making it of value in the developed state.

The cost of developing a power originally will not always represent the value of the improvements, except in so far as it relates to the character of the work done. Considering the work properly and substantially done, the value of that work immediately after completion may not be represented by its cost. A certain power may cost to develop twice as much as another of equal power, the difference in cost being due to differences in head or some other natural cause; but, all other things being equal, the one which cost double has no more value than the other, because it produces no more.

The value would depend largely, however, upon the character of the work done and the condition of the dam, canal, and wheel plant. If any portion required renewing soon, the value would be lessened; and if a general renewal of all the plant were necessary, the value would then be practically the same as though it were undeveloped.

The actual value of a plant would depend upon the amount of depreciation which had taken place; or, better, upon the number of years which it would run without renewing.

The value of the plant will be its cost, less depreciation, up to the point where the cost of water power equals that of steam power; for it would be justifiable to make an expenditure up to an amount which would give as good financial returns as any other source of power. Beyond this point, when water power costs more than steam power, the value of the improvements would not be represented by their cost.—From a paper by Charles T. Main, Mill Engineer and Architect, Boston, Mass.

A uniform system of operating accounts has been promulgated for express companies and electric railways, so far as they come under the jurisdiction of the Interstate Commerce Commission. The financial accounts for all agencies of transportation have been brought to a point at which general questions of public policy, as well as technical questions of accounting, claim consideration. In the matter of annual reports, also, many changes have been made during the past year. Such reports are now required from express companies, from electric railways, and from sleeping-car companies. The forms for reports of steam railways have been arranged so as to require a less extended report from the small railways than from the large railways. A special form of report has been advised for switching and terminal companies, as well as for lesser companies which maintain financial accounts only.

DIFFICULT PROBLEMS WHICH PUBLIC UTILITY COMMISSIONS ARE ENDEAVORING TO SOLVE[1]

By H. C. Abell.

First: The Total Value of a Property; which includes the physical or tangible value, as well as the so-called intangible value.

Second: The Proper Rate of Return on that Valuation, so that capitalists can be induced to invest in a more or less hazardous business instead of real estate, mortgages, etc.

Third: The equitable method of charging the users of the commodity and establishing standards—whether it be for a cubic foot of gas, a kilowatt of electricity, a gallon of water, a telephone call, or a car ride, so that each user pays to the Public Utility for service rendered an amount which shall bear a proper relation to the cost which he occasions the utility.

Fourth: Some method of increasing the rate of return to the Public Utility on its valuation in some proportion to the decreased cost to the public, as an incentive to the Utility to develop its business and decrease its cost per unit, and thereby decrease its selling cost to the public.

It appears at first glance that these problems should not be difficult of solution, but an analysis soon develops the perplexing and trying difficulties.

First Problem.

Total Valuations; which may be divided into physical and so-called intangible valuations.

Physical Valuation: Engineers can estimate, at prevailing prices, what it costs to replace a certain piece of apparatus, or a collection of pieces concentrated on one portion of ground or under one roof, which may be called the plant or power house, but they cannot, with the same accuracy, estimate

(a) What has been the average price paid since the utility first commenced serving the public, including the increased cost of new apparatus installed when just developed, over the later prices after the apparatus becomes standard and patents have expired;

(b) What will be and what has been the cost of necessary changes, due to the ill fitting together of these parts;

(c) What will be the changes in the art during construction, necessitating changes in plans and construction;

(d) What the increased cost will be, due to climate or labor conditions;

(e) The kind of soil and quantity of water to be encountered in all excavations;

(f) The cost of accidents, employers' liability, public liability, fire, wind, water, etc., breakage of machinery, temporary work, such as coffer dams being washed out during construction, and various other items;

(g) The increased cost of construction during operation, due to idle labor waiting for an opportunity to work, and to temporary work installed (in order to avoid interruptions to service) which is removed after permanent work is finished;

(h) The increased operating expenses, which are unavoidable due to construction work going on;

(i) The length of time necessary to construct a plant, which would affect interest while building, taxes during construction, engineering, etc.;

(j) The cost of obtaining all the actual necessary money to build the plant, and to put it on a self-sustaining basis;

(k) The unforseen litigation, injunctions, etc., which frequently increase enormously the original estimated cost;

(l) The cost of the corporate organization of the company;

(m) What the actual cost will be over the estimated cost —due to increased cost of material and labor since estimates were made, and to omissions, etc.;

(n) The necessity of laying out works, purchasing property, erecting buildings, etc., in order to provide for future extensions—at a minimum cost for the future;

(o) The present value of the plant, after depreciating the various items to allow for obsolence, inadequacy and decay, and the enhanced value, which will be considered under intangible valuation.

Intangible Valuation: It is also impossible for engineers to estimate, with accuracy the intangible valuation, which involves a consideration of

(a) The expense of obtaining a proper and efficient operating organization;

(b) The expense of maintaining an operating organization to develop business and to popularize the utility and the use of its product during the construction period, so that the plant can commence operating with the greatest possible revenue;

(c) The cost of advertising—including newspapers, posters, perodicals, personal solicitation and practical demonstrations of various kinds;

(d) The cost of appliances which are given away, or loss on their sale which includes free installation;

(e) The loss due to operation until the utility is on a paying basis;

(f) The loss in interest and profits on the investment, from the first operating period to a time when expenses and interest are earned;

(g) The enhanced value of the utility due to the increased value of its real estate, location of plant, accessibility of water, railroad facilities and sewerage, location of pipes, conduits, etc., in the streets—the latter costing much less for installation, special fittings, moving of manholes, etc., when no obstructions are met, to the extent that these items are not given full consideration in making the physical valuation;

(h) The enhanced or decreased value—due to the utility while operating having assisted and participated in the loss or development of the town or city. The utility having been an active participator in the development of the city, must be entitled to at least the same recognition as any active merchant or banker, whose business, as a going concern, is worth something; and the utility is entitled to even more consideration, since it cannot pick up its pipes, conduits, and plant and move to another city. The inactive land owner is much better off than the utility in that although he takes the same chances in the development of the city, he takes no other chances and assumes no responsibility; whereas, the utility has actively assisted in all developments, taking the many chances of loss to which only a utility is heir, including the risks involved in the work of construction, development, and financiering;

(i) The loss in the change of apparatus, due to obsolescence or inadequacy, which could not be charged as an operating expense and still maintain rates which would hold the customers and permit the financing of the company for necessary changes and extensions. One of the many examples was the changing of monocyclic generators which had been installed but a short time. An example, with which the writer is familiar, is the difference between the purchase price and the price obtained after abandonment (a change having been essential), which amounted to a depreciation of forty per cent per annum. The utility company could not possibly maintain its rates and finance this change due to evolution and development, any more than could a manufacturing concern (which had experienced the same rapid change in the art, as had many utility companies), if it were not permitted to add a charge for the cost of experiment and development to the sale price of its commodity. In the case of the utility, it is the development of the art for more efficient and reliable service in competition with other sources of supplying heat, light, etc.;

(j) The expenditures in replacing the appliances free of cost to the consumers, due to a change in the art. An example would be: a change of motors from D. C. to A. C. system, from one cycle to another, and that of operating voltage, necessitating the change of all lamps and appliances. All utility companies

[1] The Armour Engineer.

have experienced this expense, though it does not show in a replacement inventory.

The Tentative Method, now used by one of the Commissions to arrive at reproduction and present physical values, is as follows:

Reproduction Value: Five year averages are obtained from the various units which go to make up a whole; then the freight, estimated cost of installation and handling are added. To the sum of these items, which are supposed to make a completed whole, is added a percentage for engineering, interest while building, and incidentals. To the above two items is added the stock (coal, appliances, etc., on hand), and to this, the cost of paving, making a grand total for replacement. The following is a summary:

	Reproduction.	Present.
1. Land	—	—
2. Distribution System	—	—
3. Power Plant Equipment	—	—
4. Buildings	—	—
5. Office Furniture, Appliances	—	—
6. Tools, Implements and Machinery	—	—
7. Horses, Wagons and Miscellaneous	—	—
8. Total Items 1 to 7	—	—
8. Add —% for Engineering Supervision, Interest during Construction and Contingencies	—	—
Total 1 to 8	—	—
9. Stores and Supplies	—	—
10. Paving	—	—
Total Items 1 to 10	—	—

Present Value: The present value is arrived at as follows: By consultation, discussion, and investigation, a tentative life of each unit is taken; then the junk value is ascertained from values of old copper, iron, etc.; by deducting the junk value from the reproduction value, the depreciating value of the unit is obtained. The present value, if in first class operating condition, is obtained by taking the age of the unit and deducting the amount which would have accumulated in a reserve fund had an amount been set aside each year, bearing a certain per cent interest, which would, at the end of its life, have equaled the total depreciating value; its junk value is then added. If in fair operating condition, ten per cent is deducted from the present depreciating value and, if operating, but in poor condition, twenty per cent is deducted from its present depreciating value; to either of the above values would be added the junk value. To illustrate this method of arriving at present value, we may assume that the reserve fund is to be set aside at four per cent compound interest; that the cost of the unit is $1200 new; that the tentative average life is twenty years; and that the junk value is $200, and that we wish to determine the value at the end of ten years; first, when in first-class condition; second, when in fair condition; and third, when operating but in poor condition. Deducting $200 junk value leaves $1000 as the cost of the depreciable portion of the unit new. The amount to be set aside each year at four per cent, compound interest, to equal $1000 at the end of twenty years, would be $33.58. The amount set aside each year for ten years, together with its accumulated interest, would be $403.

Deducting $403 from $1000 leaves $597, to which must be added the junk value, $200, making a present value of the unit, if in good operating condition, of $797; if in fair operating condition, ten per cent is deducted from $597, making the total present value $737.30; if operating but in poor condition, twenty per cent is deducted from $597, making the present value $677.60.

Minimum service values are allowed for the various units which from point of age, might make the value of the unit equivalent to junk only, though it would be in useful operation. For instance, electric meters, which are subject to state or municipal inspection, or both, and have to be kept in a certain state of repair at all times, are allowed a minimum service value of 80 per cent of the reproduction cost; whereas, with a steam engine that has been in service a number of years but which may be in a good state of repair though not having the same efficiency as a more modern engine, or sufficiently good to put in a newly built plant, only 25 per cent of its reproduction value is allowed.

There is a great diversity of opinion among engineers as to the approximate correctness of the above method of arriving at present value.

Some engineers claim that each unit should be gone over, first obtaining its reproduction value, and then depreciating it in proportion to the cost of making the unit practically new.

Other engineers think that in addition to the above, a further amount should be deducted for depreciation in proportion to the change in the art.

Still others think that the present value of a plant should be estimated on a basis relative to most modern apparatus. As an example: Suppose it is the desire to obtain the value of a water power plant of 1000 K. W. capacity, with a load factor of 40 per cent. A figure would first be obtained for the most economical steam plant of this capacity, which, for illustrative purposes, we will assume to cost $100,000. Further assuming that the cost per K. W. hour is one cent, not including interest, and that the water power plant can develop current at ½c per K. W. hour on the same basis as that taken for steam, then the saving per K. W. hour, by using the water power plant, would be ½c, or on a 40 per cent load factor (3,504,000 K. W. hours per year), the saving would be $17,530. This sum capitalized at ten per cent (the allowable rate of return on the investment) would make the value of the water power $175,200 more than that of the steam, or give the water power a total value of $275,000. The depreciation is assumed to be included in the operating expenses.

All the above methods are influenced by the personal equation.

Second Problem.

Rate of return on the valuation: Before taking up the rate of return, I will refer to the depreciation and the amount to be set aside therefor. The line of demarcation between depreciation and maintenance is difficult to follow. Some engineers and managers think that maintenance and depreciation should all be an operating expense, as it is essential to keep a plant up to a certain point of repair at all times. They think when a piece of apparatus is replaced, the difference between the amount received for it, either as junk or an old piece of apparatus, and the cost of the apparatus replacing it, should be charged to plant account. Others think the difference between the actual cost of the old apparatus and the new should be charged to the plant account, and that the cost of the old apparatus should be charged off to an operating maintenance account. They also think that the utility enhances in value as the city develops in a larger proportion than the depreciation occurs.

Others think that an amount should be set aside each year sufficient to cover the depreciation according to assumed lives. For instance, to take the example of 1200 previously mentioned, $50.00 would be set aside each year for twenty years, if the apparatus should last that long.

There are also various opinions as to how the fund should be treated and financed.

The Commission, previously referred to, when obtaining present values, used four per cent compound interest curves knowing that the apparatus had actually reached its present life. As to the future, however, it is difficult to prognosticate what these lives will be; in fact, we are certain that a portion of the plant will not reach the estimated lives of its several parts, and that a portion may be in useful operation long after it has from point of age reached the junk value. It would seem that an amount should be allowed that would cover the probable depreciation with reference to any specific financing of the fund and the amount be changed, either reduced or increased, as necessity requires and actual experience teaches.

If an amount be set aside each year to cover the probable depreciation, some properties would soon be in the hands of

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receiver, as they would be unable to meet necessary obligations. Commissions will have to use their judgments in this matter.

The rate of return has to be large enough to induce men of money to invest in a more or less hazardous undertaking. The investment is certain to increase continually as the city develops.

The utility is subject to all the various municipal and state laws which may be passed and enforced, but unlike a life insurance company or other concern, it is not able to move away and still collect premiums from the residents of the state or municipality, or take all of its property with it.

Nearly every utility has strong competition, necessitating continuous changes. In fact, the competition with itself, in many instances, is very detrimental to returns on the investment. For instance, more efficient appliances are frequently brought out, using only 40 or 50 per cent of the commodity formerly used with old appliances. As the utility still has its investment, capacity and practically the same consumers' expense, it must devise methods and means for increasing the use to its present consumers, increasing their standard of illumination, etc. It is not probable that this can be done, especially to this large extent. To increase sales with additional consumers can be accomplished only with additional investment. The solution of this problem requires the most serious thought and best management.

It is almost unnecessary to make any mention of the changes which entail very heavy depreciation and enormously increased material from which the product is manufactured, increased cost of labor, the necessity of continuous operation during the expenditures, without any increase in earnings such as art, municipal regulations, liability to accident, increased cost of light as well as heavy demands, strikes, changes of plant, etc., when all other manufacturing concerns can shut down.

A public utility is a barometer of the condition of business. When factories shut down, the street railway patronage immediately falls off, light and fuel bills are decreased, all of which means a cut from the net profits of the utility, as its fixed expenses are practically the same.

Third Problem.

Establishing standards of service which will be fair to both the consumer and the utility, and which will be paid for by the consumer in proper relation to the cost which he occasions, and at the same time allow the utility to compete with the various other forms of light, heat, travel, etc., is a problem of large and wondrous dimensions.

In order to arrive at any solution, it is necessary to consult the manufacturer of apparatus and appliances, the operator of the utility, and the user of the utility's product. The opinions and claimed experiences of persons under each head vary greatly; but still more diversified are those of the manufacturer, operator and user. By a study of the opinions, experiences and rules already in force in various places, it is possible to arrive at some tentative rules, regulations and specifications of quality, pressure, accuracy of measurement, etc. As it is the duty of a Commission to study the various variables which enter into the cost of a product, and endeavor to arrive at a saleable and purchasable mean, they have to ascertain the quality which should be supplied, which necessitates a knowledge of the material from which it is manufactured. For example, the coal available for gas manufacture may have a high percentage of sulphur, and in order to produce a gas which would compare in the amount of sulphur present to another gas from other coal, which might be very high priced but low in sulphur, would so increase the cost of gas that it would be out of proportion for the results accomplished.

The relation between candle power and calorific value varies with the different manufactured gases. For instance, to obtain the same calorific and candle power values with coal gas as is obtained with water gas, might mean an increased cost wholly out of proportion to the results obtained.

An allowable variation of gas pressure of a fixed number of inches of water, whether the pressure is high or low, might work a hardship on either the utility or the customer. By a study of the appliance and the application of the law of the flow of gas through an orifice it is possible to arrive at a mean which is fair. As an example: a rule not allowing over 1½ inches of water differential pressure on any consumer's premises would be an exceedingly close regulation and commercially impossible for a total city distribution system, though it is possible that such a regulation might, if the matter were not thoroughly understood, be inaugurated.

As the flow of gas through an orifice is as the square root of the differential pressure, therefore increasing the pressure from 1½ in. of water to 3 in. of water would increase the flow 40.6 per cent while increasing from 3 in. to 6 in. would increase the flow only 41.6 per cent, or hardly more than from 1½ in. to 3 in. Practically all appliances are built to take care of this variation of 100 per cent, especially the Bunsen or induced air draft mixer. Take the formula

$$\tfrac{1}{2}Mv^2 = \tfrac{1}{2}M^1(v^1)^2$$

v being the velocity of the gas leaving the nozzle of the inductor, v^1 being the velocity of the air and gas together after mixture. If v^1 remains constant, and v, the nozzle pressure, varies, then with about 40 per cent increase in velocity, theoretically, about 200 per cent more air will be drawn in, so, allowing for mechanical loss in efficiency of apparatus, enough air would be brought in to make the proper combustible mixture. A differential pressure of 1½ in. between initial and final pressure would pass 52,000 cu. ft. of gas through a mile of pipe, with an investment of $15,840, while a 3 in. differential pressure would pass 73,000 cu. ft. of gas, or 40 per cent more, through the same mile of pipe.

From the above it can be seen that a rule specifying a certain differential pressure as 1½ in. would mean a greatly increased investment and not help the consumer much more than the 100 per cent allowable variation in pressure from a minimum which is allowed by one commission.

Even the latter allowance, if strictly followed in every case and for all hours of the day, might work a hardship on the customer and the utility by necessitating the payment of interest on a heavy investment for a very short period of use.

It can be seen that the establishing of standards and forcing the utility to comply with them in every particular, is a problem for engineer, financier and economist.

Equitable charging would have to be based on the cost of the consumer to the utility, in order that each consumer might bear his proper proportion of the expense which he occasions. As an example: a large store may have a demand of 400-16 candle power lights and only use them on an average of one hour per day; whereas, a small concern may have a demand of only 26-16 candle power lights and use them twenty-four hours per day; each would consume the same amount of current; each consumer's expense would be approximately the same; the output expense for current consumed would be approximately the same; but the capacity of the generating plant equipment, lines, transformers, etc., would be twenty times more for the large store than the required capacity for the smaller concern. It is, therefore, necessary to subdivide the expense in order to ascertain what the expense of an additional consumer will be, what the fixed expense will be per unit of capacity demanded, and the cost of the commodity per unit sold.

There are some expenses which are common only to the consumers, such as reading meters, delivering and collecting bills; others, proportionate only to output, such as coal carbonized for gas manufacturing; and still other expenses proportionate to output and capacity, such as steam. A part of the steam is used to operate exhausters, which take gas from the hydraulic main. The amount of work performed is in proportion to the gas made; whereas, the amount of steam used for heating the buildings and keeping the holder cups from freezing in the winter, is not in any way influenced by the amount of gas manufactured by that capacity of plant. To go into the several items of expense and endeavor to arrive at a correct subdivision would take considerable space. As an illustration, I will touch on one or two items:

The steam account for electric generation is very difficult of analysis between fixed and output expense. If engines were

operated continuously at the most economical load, the cost per unit generated would be less than at variable loads, which actually occur in an electric plant. Boilers are frequently banked, and all the fuel used for banking fires or starting up a boiler each day for peak loads is probably a capacity expense. Engine and dynamo labor, and frequently boiler room labor, would be no greater if all the engines were running continuously at 100 per cent load factor. It can be very plainly seen that as the load factor increases, the operating expenses are decreased per unit of electricity sold.

In order to approximate a correct proportion to be charged to capacity, it would be necessary to assume for a basis, some ideal load factor.

There is a great diversity of opinion regarding the division of General Expense which usually includes executive salaries, general office expense, general office clerical salaries, office rent, legal expense and an incidental general expense, like the publishing of annual reports, stockholders' meetings, etc. Some accountants call this a contributary or overhead expense, and divide it in proportion to the sum of manufacturing, distribution and collection expenses which are subdivided into capacity, consumers and output.

The interest on the investment is frequently subdivided in the same proportion between the capacity, consumers and output, as the example of the general expense just given.

A tentative summary of the division of Yearly Expenses for a Gas Plant are given below:

	Capacity.	Consumer.	Output.
Manufacture	$ 2,288.65	$.....	$38,839.00
Distribution	7,531.79	12,929.92	1,917.00
Collection	230.66	3,775.35	.....
Operating Expense, except General Expense	$10,051.10	$16,705.27	$40,756.00
General Expense	2,156.74	3,594.57	3,626.98
Depreciation	8,405.00	1,845.00	2,000.00
Rate of Return	7,460.09	12,500.69	30,445.22
	$28,072.93	$34,645.53	$81,828.20

$1.27 per meter, $8.45 per consumer, 78c per M for gas.
22,000 Meter light capacity connected, 6 cu. ft. per light.
4,100 Consumers.
105,000,000 cu. ft. of Gas Annual Sales.

From the foregoing figures the fixed charge for the various connected capacities would be as follows:

5 Light Meter per Year	$ 14.80
10 Light Meter per Year	21.15
20 Light Meter per Year	33.85
30 Light Meter per Year	46.55
45 Light Meter per Year	65.60
60 Light Meter per Year	84.65
100 Light Meter per Year	135.45

Besides the above fixed expenses the consumers should pay 78c per thousand cubic feet for gas.

A complete analysis of the consumers' accounts should now be made, together with their connected capacities for demand; then, by taking the maximum rate per unit for the commodity at that time in force, and applying the following equation:

$$A + Bx = Cx$$

it is possible to see how many of the customers should have their bills raised or lowered.

A = Yearly charge on the connected load or demand.
B = Output cost of gas.
C = Maximum rate per M. cu. ft. then in force.
x = Number of cu. ft. of gas used per year.

Example: Assume a five light meter was installed and that the maximum rate for gas was $1.25 per M. cu. ft. How many cubic feet per year would a consumer have to use in order to pay the company all expense which he occasions it, together with a proper rate of return on the investment, when the capacity expense is $6.35, consumer's expense $8.45, and output price of gas 78c per M. cubic feet?

$$A = \$6.35 + \$8.45 = \$14.80$$
$$B = 78c.$$
$$C = \$1.25.$$
$$\$14.80 + .78x = \$1.25x$$
$$x = 31{,}500 \text{ cu. ft. per year.}$$

By the foregoing method it is found that 80% of the total consumers had not been paying the amount which they should.

The difficulty of obtaining and installing rates which are fair and equitable and at the same time sufficiently satisfactory to the prospective customer who is not now, but after a proper introduction to the use of the commodity, may become a very profitable consumer, is obvious. There are many rates in use and it devolves on a Commission to study them all, together with an analysis of costs, and endeavor to arrive at something which will be the most equitable for all concerned,—a task which is more than arduous.

Fourth Problem.

To increase the rate of return to the public utility in some proportion to the decreased cost to the public.

There are several methods now used, or proposed, to accomplish the above results, based on the "London Sliding Scale," or some modification of it.

The first part of the problem is to set the initial price, which, of necessity, has to be fair, whether it be a maximum or average price per unit for all the commodity sold. After solving problems two and three, the price will be fairly well determined for an established concern. To obtain this price requires study and investigation, and a thorough knowledge of all the factors for each specific case. The cost of material from which the product is produced varies, as do practically all the factors which go to make up the cost. The price has to be sufficient to take care of any normal fluctuation, without working detrimentally to either the customer or to the utility. Whenever any abnormal variation in the price of material, etc., occurs, it has to be taken care of by some other means. Sometimes a certain per cent is set aside in a reserve fund until it reaches a certain amount—a percentage of the investment, gross earnings or some such basis. This fund is kept to take care of variations in price of manufacturing material, decreased earnings in bad years, etc.

A solution of Problem No. 2 will give the initial percentage to be allowed as a rate of return on the investment, after which the ratio of increased allowable net earnings to decrease in price, will have to be determined.

As the price is decreased it becomes more and more difficult to make further reductions, hence a Commission has to determine whether these increased premiums to the utility should be on a differential scale to stimulate greater effort on the part of the utility to improve the physical and financial service to the public. or whether some permanent arrangement should be enforced allowing a utility a fixed per cent increased net earnings, with a specific decrease per unit of the commodity sold.

Whatever method of increasing the rate of return is used, it will have to include the consideration of the availability of service, extensions in new districts, etc.

I have suggested but four general problems. As has been seen, each of these involve many intricate and difficult questions which will undoubtedly require many years of study and labor to properly solve.

The electrolytic manufacture of aluminum was commenced at New Kensington in America in 1888 and at Newhausen in Switzerland in 1889 under patents granted to Hall and to Heroult respectively. The Bradley patent for keeping the bath in a molten state, which expired last year in Europe, expires this year in America. In Europe aluminum is selling at 13 cents per pound while here it is now about 23 cents, and will undoubtedly drop when the Bradly patent becomes public property.

CURRENT COMMENT

Permits for steam pipe lines may be granted by the San Francisco supervisors, according to an opinion rendered by the city attorney.

The Kobe Street Railway Company is negotiating a loan of $500,000 with French capitalists to be used in constructing and equipping the road at Kobe, Japan.

The wireless telegraph summoned five vessels to the aid of the White Star liner Republic, which with 761 people on board, was rammed by the liner Florida, 26 miles south of the Nantucket lightship, last week.

Calcium carbide was first produced on a large scale by Wilson at Spray in the United States in 1893. Wilson's patents were not upheld in Europe owing to the earlier publication of Moissan's chemical researches upon the electrical furnace and its products.

The constitutionality of the Federal forest policy is to be tested if a measure be passed by the Colorado legislature which authorizes the attorney general to prepare cases involving the question of the unconstitutionality of Federal forest reserves within the boundaries of sovereign states.

The highest generator voltage in use is that at a hydro-electric plant at Manojlova Falls on the Kerka river in the Province of Dalmatia, Austria-Hungary, which generates electric current at 30,000 volts. This is fed direct to the line without the use of step-up transformers and transmitted twenty-one miles to a calcium carbide works.

Examination for Engineer in the Indian service, is announced by the United States Civil Service Commission on February 17, 1909, to secure eligibles from which to make certification to fill a vacancy in the position of engineer (competent to take care of pumping plant, tank house, etc.), $720 per annum, Indian Service, Fort Berthold, North Dakota, and vacancies as they may occur in the Indian Service.

A Norwegian market for spiral pipe is possible according to Consul Felix S. S. Johnson, who writes from Bergen that the waterfalls of the country are being gradually taken up, and their power in some instances is carried by means of pipes several miles. A proposition is now being considered by the city council to unite the streams in and around Bergen by means of tunnels and pipes, affording manufacturers and others electrical power.

Electricity passing through a whip killed Henry Holiman near San Jose, California. According to a newspaper report Holiman, together with the son of his employer, M. C. Vennum, were washing a wagon during a rainstorm. While they were standing with their hands on the wheels both experienced an electric shock and were hurled to the ground. Vennum was not seriously hurt, but Holiman did not regain consciousness and died within a few minutes.

Gas engines supplanting Dutch windmills. According to Consul-General S. Listoe of Rotterdam windmills are principally used in Holland for the purpose of pumping water out of drain ditches, which must be done regularly in order to keep the fields and meadows dry, the greater part of the Netherlands lying below the level of the sea. It is claimed that wind is too uncertain a motive power for the purpose mentioned, and hence gas motors are gradually being introduced.

The demand for gas in Tokyo is steadily increasing. The advance in the price of charcoal and firewood is rapidly forcing the public to avail themselves of gas for cooking purposes. It is expected that the rate of dividend to be distributed by the gas company for the present half year will exceed 10 per cent per annum. The increased demand for gas has necessitated the extension of the company's works and the payment of a further $6.25 on the new shares of the company will be shortly called up to provide funds for the extension.

The Tuilieres hydro-electric works, the largest of the kind in France, is nearly completed. It is 10 miles from Bergerac (Dordogne). The power will be 23,000 h. p. It is built on the River Dordogne, which has been dammed. The water drives nine 2,700 h. p. turbines. The hydraulic works is supplemented by a steam works with Curtis turbines and 6,000 kilowatts Thomson-Houston alternators. The current is supplied at 55,000 volts, and conveyed 62 miles to Bordeaux, 28 miles to Periguex and 74 miles to Aledin Angouleme.

The Michigan Central will electrify all the terminals at Detroit, and the main line as far west as Ypsilanti, thirty miles from Detroit. It is planned to abolish local trains and use large electric cars for local business, having the steam trains stop only at the large cities. Electric power will be generated by a waterpower plant to be built in the Huron River at Chelsea, Mich. The plans are said to contemplate the use of electric locomotives to draw trains from Ypsilanti into Detroit and through the tunnel now being built under the Detroit River.

The Niagara power treaty for the settlement of differences between the United States and Great Britain relating to Niagara Falls and the Great Lakes has been signed by Secretary Root and Ambassador Bryce. The treaty requires that the level of Lake Erie must be maintained, and permits Canada to use for power purposes at Niagara 36,000 cubic feet of water per second, and fixes the amount for the United States at 20,000 cubic feet, an increase of 1,500 cubic feet over the amount recommended by the International Waterways Commission to dispose of future problems that may arise in administering its provisions.

Water-power development in Tasmania, Australia, is confined to the city of Launceston, where for thirteen years a portion of the water power available in the South Esk River has been used by the municipality for the electric lighting of the city. The power station is 2 miles from the city, and the machinery comprises four three-phase generators and turbines of 450 horsepower each. In the city there are over 30 miles of streets lighted by electric lamps, and business places and private houses use the electric light largely. Electricity is also used for motors and heating appliances. The municipal council of Launceston has so far spent over $800,000 in constructive work. No state in Australia has such abundant water power as Tasmania, but as yet, however, there has been no systematic investigation, either by the government or by private persons, as to the cost of developing most of this power. The interior of Tasmania is mostly 1,500 to 2,000 feet above sea level. The moisture laden clouds from the northwest discharge most of their contents on the first highlands they meet. In the northwestern part of this plateau there are a number of great lakes, the four principal ones being Lake St. Clair, Lake Echo, Great Lake, and Lake Sorell. In the northwestern part of this lake country the rainfall is said to average 84 inches, but at the southeastern end only about 35 inches. Any successful power plant, therefore, would probably necessarily be located in the northwestern part of the lake region. It has been roughly estimated that from Lake St. Clair could be produced a minimum of 46,000 horsepower, from Lake Echo 9,000 horsepower and from Great Lakes 27,000 horsepower, a total of 82,000 actual horsepower. These three lakes are from 2,000 to over 3,000 feet above sea level, and it is said that as natural reservoirs they could, by comparatively small expenditure, store the abundance of rain falling in the wet season for use during the dry season.

JOURNAL OF ELECTRICITY
POWER AND GAS

PUBLISHED WEEKLY BY THE
Technical Publishing Company

E. B. STRONG, President
E. M. SCRIBNER, Vice-President and General Manager
A. H. HALLORAN, Secretary and Managing Editor

DIRECTORS
R. J. DAVIS A. M. HUNT E. M. SCRIBNER C. L. CORY E. B. STRONG

604 MISSION STREET, SAN FRANCISCO.

TELEPHONE . . . . . KEARNY 918

TERMS OF SUBSCRIPTION

United States, Cuba and Mexico	per year,	$2.50
Dominion of Canada	"	3.50
Other Foreign Countries within the Postal Union	"	4.00
Single Copies, Current Month	each	.10
Single Copies, prior to Current Month	"	.25

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FOUNDED 1887 AS THE
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Voltage Regulation

About four o'clock these dark afternoons our proof-reader turns on his electric light. At first it burns brilliantly, but at the end of half an hour it is reduced to a dull yellow glow that only seems to accentuate the darkness. Soon, however, it brightens with a dazzling brilliancy and gladdens his eyes, until suddenly it is again dark—the lamp has burned out. This little scene, with variations, is enacted daily all over the country. It is caused by poor voltage regulation. It makes dissatisfied customers, who may finally order their meter taken out, and it also means that the lighting company is losing money, for a lamp that is burning low is using much less current than one giving a normal light. For years it has been the operator's most important duty to keep the voltage steady. Now there are several devices on the market which do this work automatically. The question therefore arises as to how far this automatic regulation can proceed. The opinions of several engineers in Southern California on this question were brought out during the course of the discussion on a paper by Mr. J. A. Lighthipe, which we publish in this issue. Mr. Lighthipe is a veteran in this field, having been connected with the earliest lighting plants in the West "before the power factor was born." His reminiscenses of early days are interesting and suggestive. The concensus of opinion of those entering into the discussion seems to be that, while regulation is comparatively as far from perfection to-day as it was at the beginning of things, yet its great progress and success to date justifies hope for the near future. There is little likelihood, however, that we can ever dispense with "the tireless, sleepless, more or less reliable attendant, who must still at times come on the scene and save the day, as of yore."

Central Station and Railway Statistics

Through the courtesy of Mr. T. C. Martin, expert special agent for the Bureau of the Census, we are enabled to present preliminary statistics on the central stations and the electric railways of the United States for 1907, which are to be followed by similar data on the telephone and telegraph industries. These, together with the corresponding figures for 1902, appear on another page of this issue.

An examination of the central station report shows that the total investment, exclusive of isolated plants, was a billion dollars, nearly double what it was five years previous. In the same period the income has more than doubled, the output is two and one-third times greater, and the capacity of the hydro-electric generators nearly three times as great. To use this current the number of incandescent lamps

has been more than doubled, and the number of stationary motors nearly quadrupled.

Of electric railroads there are 34,404 miles, 5 per cent of which, by the way, are in California. The 83,641 cars carried nearly ten billion passengers of which nearly two billion rode on transfers. To run these cars and operate electric light plants in connection with them required 4,759,000,000 kilowatt hours. The gross income for the year 1907 was nearly $430,000,000, of which over $25,000,000 was paid in dividends.

The data shows that in five years' time these two industries have practically doubled in everything except dividends, which unfortunately have been low enough to satisfy the most exacting public service commission that the corporations are not all getting rich over night. The net income of the central stations would pay but 4 per cent on the investment, while that of the railways gave a 2½ per cent return on capital invested. These apparent figures should be a trifle higher, as interest on the bonds is figured as an expense.

ANNUAL DINNER AND SMOKER, LOS ANGELES SECTION A. I. E. E.

The largest gathering of Electrical men ever assembled in Los Angeles turned out to the dinner and smoker held on the nineteenth of January. One hundred and forty-two members and their friends accepted the invitation sent out by the local section of the American Institute of Electrical Engineers.

Mr. V. L. Benedict worthily filled the position of toastmaster, while Mr. H. C. Bowers officiated as Chaplain.

The toastmaster in his usual good natured style took a rap at everybody in sight and his victims were not far behind in their responses. It was necessary to appoint big Bill Smith as bouncer before the "Agony Quartette" composed of Messrs. Morris, Clapp, Green and Lewis, got through singing their parody rendition of "Bible Tales."

"BIBLE TALES.

Absalom he wore his hair quite too much pompadour,
Got mixed up with a tree and Abie cut his hair no more,
Manahan was right behind, a scootin' like the deuce,
He escaped for on his curl he used high potential juice.

Noah heard an awful row and cries for a square deal,
Said Tiger, "Here's an extra monk, I'd make a better meal,"
But looking closer Noah found the monk was one of you,
But even if you offer thirty cents he won't tell who.

Ballard was the engineer of Noah's famous bark,
Put electric lights on her, some tungstens and an arc,
You have heard of mastodons; the reason they're extinct,
'Twas to make room for Arthur, they were pushed off in the drink.

There was a King in Bible times who had a funny way
Of shoving folks he didn't like in a furnace hot to stay,
Once he was taken by surprise when he shoved in a batch,
Lighthipe peeked outside the door and asked him for a match.

The usual placid countenance of City Electrician Manahan was transformed by the thirteenth verse which the quartette would insist on repeating. The bouncer managed to keep order while the quartette finished in triumph, although even the headwaiter said it was fierce.

Mr. A. S. Havens entertained those present with a remarkable sleight of hand performance with cards. So far as known none of the silverware or dishes disappeared.

Mr. W. J. Clark of New York, gave a very interesting talk on "Heavy Traction." Among the other speakers were Mr. C. W. Koiner, Chairman of the Local Section; Mr. Walter Fagan, Mr. R. H. Manahan, who also contributed a Chinese song, while Mr. B. A. Wagner whistled himself into the good graces of the audience.

The evening's entertainment concluded with an half hour's demonstration on high voltage, high frequency apparatus by Prof. H. LaV. Twining. A specially constructed "Oudin resonator" with the usual form of transformer and condenser used in wireless telegraphy, provided a very spectacular exhibition.

PERSONAL.

George A. Packard, metallurgist and mining engineer of Boston, was in San Francisco this week.

H. B. Vanzwoll, secretary of the Sunbeam Incandescent Lamp Company, Chicago, Ill., will make his annual trip to the Pacific Coast in March.

W. H. Bissell has resigned from the employ of the Great Western Power Company to become manager of the Livermore Water and Power Company, succeeding D. J. Murphy, of Livermore, resigned.

C. W. Scott, manager of the San Francisco office of H. W. Johns-Manville Company, is attending the regular convention of managers of his company in New York City, and will return about the middle of February.

H. C. Rice, vice-president of the General Incandescent Lamp Company, Cleveland, O., is planning a trip to the Pacific Coast for some time in March or April. It has been about 18 months since he favored this section with a visit and the many friends he made during his former visit will be unusually glad to see him again.

F. E. Wilson, who is associated with the Franklin Electric Company, manufacturers of the Femco Incandescent Lamp, of Hartford, Conn., is now in San Francisco and will spend some weeks upon the Pacific Coast in the joint interest of his company and the Holabird-Reynolds Electric Company, who represent them in this territory.

Edward C. Brown, manager of the Hawaiian office of the Dearborn Drug and Chemical Works, at 42 Queen Street, Honolulu, is making an extensive Oriental trip of three or four months, during which he will visit Japan, the important sea coast cities of China, Australia, the Philippines, Java, and other important islands in the Pacific Ocean.

H. S. Salt, well known in San Francisco through his connection in years past with the old California Electrical Works, and who has for the past two years been associated with the Dale Company of New York as manager, severed his connection with that company under date of January 1st, and has opened an office in New York City as manufacturers' representative. His many friends on the Pacific Coast join in wishing him success in his new undertaking.

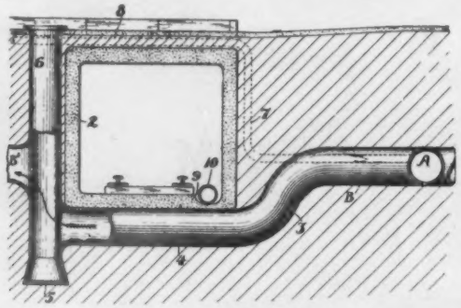
OBITUARY.

John J. Lewin, one of California's foremost electricians, died January 24 at his home near San Jose.

For ten years the decedent was electrician of Leland Stanford University, and at the time of his death was city electrician of Palo Alto. To him is credited the introduction of incandescent lighting in California. He was recognized as a man advanced in his profession, and at the time of the wedding of Miss Theresa Fair and Hermann Oelrichs he was called upon to install all the elaborate lighting for that event.

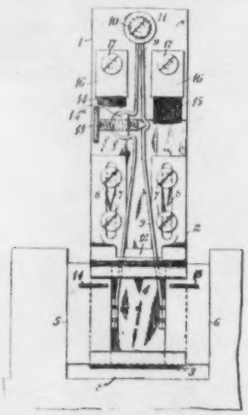
PATENTS

908,980. System for Conducting Water and Sewage Through Tunneled Streets. John J. Eagan, San Francisco, Cal. Filed Aug. 17, 1906. Serial No. 331,054. 1. A system for conducting water and sewage through tunneled streets consisting in combination with the tunnel having a longitudinal trough containing a pipe at one side of the base of said tunnel, a sewer-pipe lying transversely in close proximity to said base



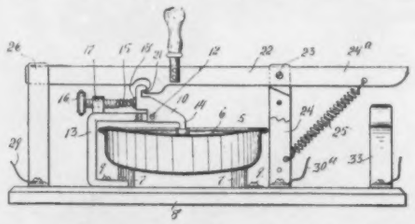
of the tunnel, said pipe curving upwardly at one end and thence extending laterally, a manhole at one end of said tunnel leading vertically from the sidewalk to said pipe, and a downwardly flaring basin for sediment at the base of said manhole, said basin extending below said pipe, and a pipe running transversely over said tunnel and thence continuing downward vertically in proximity to the other side of said tunnel and thence extending laterally to the main longitudinal sewer.

909,834. Brush-Holder for Dynamo-Electric Machines. Miles Walker, Hale, England, assignor to Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa. A brush holder comprising a frame or base plate of conducting material having guide projections that produce a lateral recess,



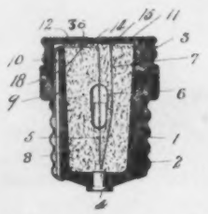
one of said projections being adjustably attached to the frame, brush blocks movably mounted in the recess and electrically connected to the frame, and a V-shaped spring secured to the frame and having resilient arms which engage the adjacent surfaces of the contact blocks.

909,818. Thermo-Electric Alarm. John E. Paul and James M. Stewart, Denver, Colo., assignors of one-third to George W. Dolezal, Denver, Colo. In a thermo-electric alarm, the combination with two circuits, signalling devices located in the respective circuits, and a movable device arranged to make or break the said circuits alternately, of a sealed fluid container provided with a flexible diaphragm adapted to be actuated by the expansion or contraction of the fluid within the container, and a suitable connection between the said diaphragm and the movable circuit-closing part whereby when the diaphragm is in one position the said movable part is held



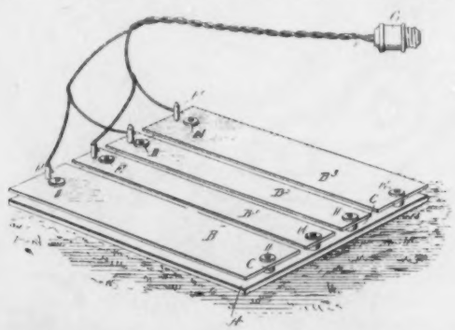
in position to close one circuit, while when the diaphragm is in the opposite position, the said movable part is caused to move into position to break one circuit and close the other circuit.

909,564. Electric Fuse. Louis W. Downes, Providence, R. I., assignor to D. & W. Fuse Co., Providence, R. I. In a plug-fuse, a cup-like or hollow plug casing; a main fuse-wire inclosed by the casing, a cover closing the open end of the casing; indicating means including an auxiliary or indicator fuse-wire in parallel circuit, with the main fuse-wire, and



a small body of suitable combustible material associated with the cover and indicator wire and adapted upon fusing of said indicator wire to afford at the exterior of the cover a visual indication of the condition of the main fuse-wire; and an outer transparent suitably noncombustible covering applied to the cover over the indicating means.

909,814. Electric Trap for Rats. John T. Norris, Troy, N. C., assignor of one-half to Christopher C. Wade, Troy, N. C. An electric trap comprising an insulated base a series of conducting plates separated from each other and supported on



said base but insulated therefrom, and positive and negative wires adapted to be connected with a source of electrical energy and with alternate plates.

909,507. Prism for Electric Lamps. Justus C. Zubli, Seattle, Washington. An attachment for electric lamps comprising a reflector for engagement with the bulb of the lamp, a prism rotatably mounted in front of the lamp bulb, the mounting of the prism being carried by the reflector and means in connection with the mounting for permitting the prism to swing with respect to the lamp.

INDUSTRIAL

THE 110,000 VOLT TRANSMISSION LINE OF THE GRAND RAPIDS MUSKEGON POWER COMPANY.

Considerable interest has been aroused by the 110,000 volt transmission line of the Grand Rapids Power Company which, now that it has been operating satisfactorily for six months, has proved the entire practicability of this voltage for long

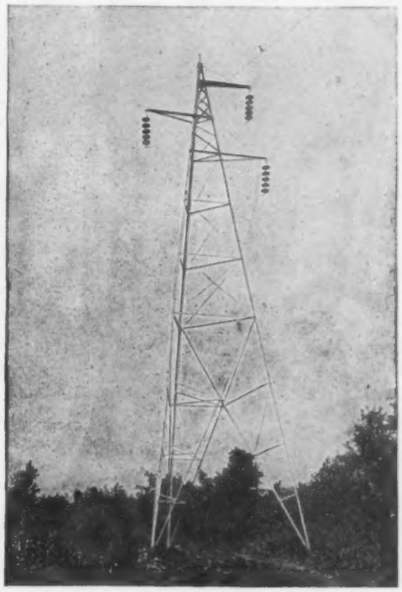


Fig. 1. Steel Tower With Suspension Insulators.

distance electric transmission of power, runs between Grand Rapids and the Croton dam, Michigan, and is fifty miles in length. The line is carried on triangular steel towers which are approximately 53 feet in height over all and 43 feet, 8 inches from the ground to the lowest cross arm, and which were de-

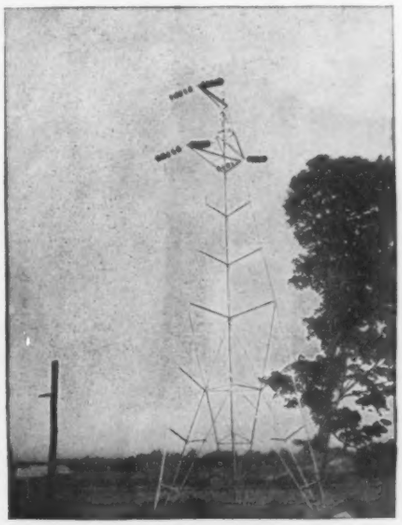


Fig. 2. Steel Tower with Strain Insulators.

signed to give a 40 foot clearance between the line wire and the ground. The towers weigh approximately 1,700 pounds each and provide a minimum spacing between the insulator hangers of 8 feet; they are placed on large concrete anchors buried in the ground and are spaced 528 feet apart on tangents, (Figs. 1 and 2). The anchors consist of 3 inch angle steel, 7 feet and 10 inches long, encased in concrete. The anchors each extend about ten inches below the bottom of the concrete in which

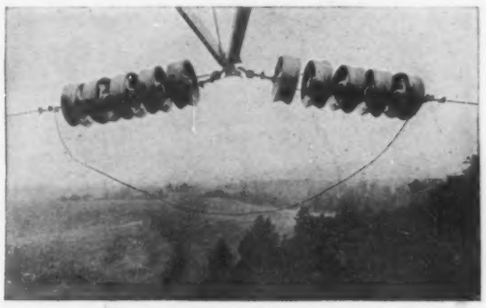


Fig. 3. Strain Type General Electric Disk Insulators.

they are encased, thus securing a ground for the transmission line.

In view of the many troubles experienced by the large majority of companies when first starting a high tension transmission

Fig. 4. Suspension Type General Electric Disk Insulator.

line using pin insulators, a report made on the operation of this line is of special interest. This report states that "this line has been in operation since July 18th last and we have experienced no trouble whatever. Nothing of an unusual nature

Fig. 5. Croton Dam Generating Station.

has occurred and we consider its operation as very satisfactory and successful."

The majority of the right of way is located along the highways, and only a tower right was taken. Where the line

passes through forests or makes short cuts across country, a strip of land was purchased, varying in width from 33 to 66 feet, according to circumstances. This land is usually fenced off. No protection whatever is used where the lines cross highways or traffic routes.

The insulators are of the standard General Electric disk pattern, the suspension type being used for a straight support and the strain type for pull-off curves. Five of these 10 inch disks

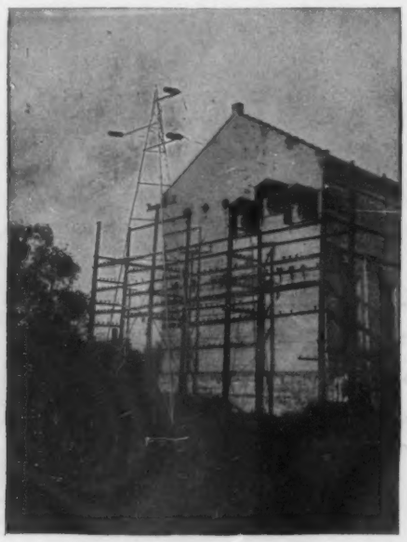


Fig. 6. Rear View of Croton Dam Generating Station.

are used in series, the arrangement being very clearly shown in Figs. 3 and 4. Each disk is rated at 25,000 volts.

The line transmits 10,000 k. w., the conductors consisting of No. 2 stranded hard drawn copper wire with hemp center. The lines are spaced 8 feet apart and are entirely without transposition throughout the whole length. No guard wire is used.

The lines are brought into the stations through porcelain insulators and are connected directly to the high tension transformers, which are delta connected on both sides. There are no

Fig. 7. Static Discharge From the Line.

switches of any kind in the lines, the control being by means of generator field switches.

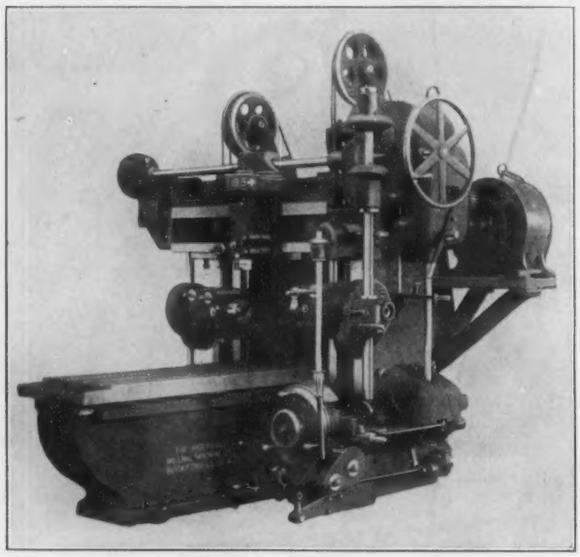
The pressure was first applied to the transmission line on July 18, 1908, and it was noticed that the line was a little noisy at the working pressure of 110,000 volts, while at night the atmospheric discharge was distinctly visible. Wattmeter ratings on the empty line, after deducting the core losses of the step up transformers, seemed to indicate a constant loss on the 50 miles of line of from 20 to 25 k. w.

Other interesting features of the line are shown in Figs. 5 to 7 inclusive.

A MOTOR DRIVEN THREE HEAD MILLING MACHINE.

The special operations involved in the manufacture of various products have led to the devising of new machines and the modification of existing machines to meet the new needs. The phenomenal growth of automobile manufacturing in recent years and the special parts to be machined have given rise to the production of the milling machine shown in the accompanying illustration.

The tool is designated by the manufacturers, the Ingersoll Milling Machine Company, as the Automobile Type Milling Machine, and is made particularly for milling engine bases and transmission cases of automobiles. It is, however, not only adapted for this work, but for any other work which may be machined on either a planer or milling machine. The three spindles have speeds varying from 15 to 120 r. p. m. The speeds are arranged for face mills up to 10 inches in diameter for steel or cast iron, but for aluminum work larger



Motor Driven Three Head Milling Machine.

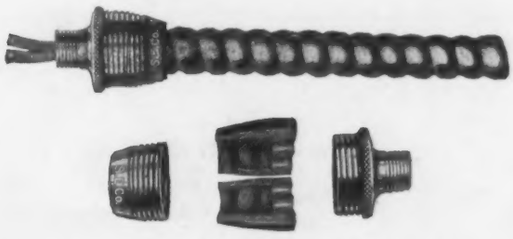
cutters may be used. The machine has a capacity of 26 inches between the ends of the horizontal spindles, and 24 inches between the table and vertical spindle.

The motor equipment consists of a 15-horse power, direct current, shunt wound, Westinghouse Type S motor. The motor is mounted on a bracket in the rear of the machine, where it takes up little space and does not interfere with the work or the operator. The speed changes, from 875 to 1,500 r. p. m., are effected by variations in the shunt field by means of a Westinghouse drum type controller, not shown in the cut. In addition to the range of speed thus obtained, there are four changes by mechanical means. This enables the cutting speed required by the work to be obtained with exactness and maintained with certainty. In the case of machine tools especially is it desirable to have a perfect control and adjustment of the speed; and undoubtedly the most satisfactory method of obtaining this is by means of the adjustable speed motor and a suitable controller.

Harvard Electric Company, Chicago, report that the new Harvard Patent Galvanized Channel Steel Bracket is meeting with success since it was placed on the market a few months ago. The firm has sent out a number of brackets on approval and has received orders and testimonials relative to its serviceable qualities. This line includes steel construction material for telephone, telegraph, electric light and power transmission work in the way of brackets, foot and corner S traps, pole fixtures, construction tools, etc. Mr. Allen L. Haase, for years actively identified with the Steel Bracket industry, is now sales manager of the Harvard Electric Company, 66 W. Van Buren Street, Chicago, and 136 Liberty Street, New York City.

NEW BRASS INSULATED BUSHING.

Complying with the National Board of Underwriters' rule that lamp sockets must be insulated from the armor of armored cord the Sprague Electric Company has developed a new brass insulated bushing. It consists of two brass parts and two composition insulating wedges as shown in the sectional view. The brass



parts of the bushing are insulated from the steel armor by two composition insulating wedges which grip the armor as the bushing is screwed into place. Thus these bushings provide thorough insulation between covers of boxes and sockets and the cord armor.

TRADE CATALOGUES.

The Terry Slow Speed Steam Turbine is illustrated and described in Bulletin No. 16 from the Ohmen Engine Works of San Francisco.

Bulletin No. 47 from the Eck Dynamo and Motor Co., is devoted to motor-generators and is arranged to be filed in their sectional catalogue and data book.

MacGovern, Archer & Co., 114 Liberty street, New York City, have issued a list of second hand electrical and steam apparatus which they have in stock.

Bulletin No. 19 for the H. Krantz Manufacturing Company, of Brooklyn, N. Y., is devoted to their Type H Knife Switches, single, double and four pole, single and double throw, back and front connection, fused and unfused.

Automatic High Speed Engines for direct connected work is the title of a handsomely printed and bound bulletin, No. 10, ssued by the Ohmen Engine Works, 17th and Capp streets, San Francisco. These engines are of the highest class, designed and built specially for high duty and continuous service, as is shown by illustrations of a large number of installations. This catalogue also contains valuable data on computing power, including a table of power ratings.

In Folder No. 3744 just issued by the General Electric Company is described the company's transformer for use in connection with moving picture machine arc lamps. The transformer is known as The G. E. Economy-Arc, and the advantages claimed for it are reduction of light bills, simplicity of operation and safety. The saving in power insured by the use of a transformer instead of a rheostat varies from 65 to 90 per cent, depending upon the voltage of the circuit.

Bulletin No. 4637, recently issued by the General Electric Company, illustrates and describes various styles and sizes of Tungsten Incandescent Lamps for Battery Service. The high efficiency of the Tungsten filament renders it especially suitable to the production of an ideal battery lamp where high efficiency is necessarily a prime requisite. The bulletin illustrates and describes battery lamps, novelty lamps, surgical lamps, lamps for limousine automobile lighting, and various other styles with miniature bases and bases adapted for use in standard sockets. The bulletin contains also prices of the various types.

TRADE NOTES.

The Holabird-Reynolds Electric Company of Los Angeles and San Francisco, have been appointed sales representatives for the Sachs Company of Hartford, Conn. They will carry a full line of non-arcing enclosed fuses and electrical protective devices.

SUNBEAM LAMP REMOVAL.

The Sunbeam Incandescent Lamp Company, Chicago, has moved its sales office and warehouse from 32 West Polk Street, to the Western Electric Company Building at 259 South Clinton Street, Chicago. This change was made as larger quarters were needed to properly take care of the increased volume of business handled by both the Sunbeam Company and the Western Electric Company since the adoption of the Sunbeam Tungsten lamp. The Sunbeam product is well and favorably known, having been on the market continuously for twenty years. They manufacture a complete line consisting of, in addition to regular lamps, Gem, Tantalum and Tungsten filament lamps of all styles, candlepowers and voltage. The entire output of the Sunbeam Incandescent Lamp Company is distributed through the Western Electric Company, Chicago or New York, and their various branch houses throughout the United States.

COAL BRIQUETS ON LOCOMOTIVES.

In co-operation with the Missouri Pacific, the Lake Shore and Michigan Southern, the Michigan Central, the Chicago, Rock Island and Pacific, the Chicago, Burlington and Quincy, and the Chicago and Eastern Illinois railroad, 100 locomotive tests have been made by the United States Geological Survey to determine the value, as a locomotive fuel, of briquets made from a large number of western coals. All tests were made on locomotives in actual service on the road. In some tests there was small opportunity for procuring elaborate data, but in others, where dynamometer cars were employed, it was possible to obtain more detailed results. The purpose which these tests were intended to serve was not so much to determine the evaporative efficiency of briquets as to investigate their behavior in practical use.

Briquets made from Arkansas semianthracite, two qualities of Indian Territory slack, Indian Territory screenings, Missouri slack, Indiana Brazil block slack, coke breeze, and a mixture of coke breeze and washed Illinois coal were tested, and comparisons were drawn either with the same coal that was used in the briquet or with coal similar to it. In nearly every test the results reported show that the coal when burned in the form of briquets gives a higher evaporative efficiency than when burned in the natural state.

For example, Indian Territory screenings give a boiler efficiency of 59 per cent, whereas briquets made from the same coal give an efficiency of 65 to 67 per cent. Decrease in smoke density, the elimination of objectionable cinders, and an apparent decrease in the quantity of cinders and sparks are named as the chief reasons for this increased efficiency.

The cost of briquetting, including all charges, is estimated to be about $1 per ton of briquets; that is, the briquetting added approximately $1 per ton to the cost of the coal. The briquets were made, however, in an experimental plant, and the price is for this reason probably not so low as if they had been made on a much larger scale.

The briquets were made by the fuel-testing plant of the United States Geological Survey at St. Louis. The coal was shipped from the mine at Lloydell under the supervision of an inspector of the survey, who at the same time obtained nine samples. The samples were hermetically sealed and sent to the St. Louis laboratories for analysis. After the coal was made up into briquets it was returned to the locomotive testing plant at Altoona, Pa., for the tests.

To observe the effects on briquets of exposure to the weather, a number of the round and square briquets were placed on the roof of the testing plant. After four months of exposure for the round and three months for the square briquets, no change whatever from their original condition was noticed. They appeared to be entirely impervious to moisture and were still firm and hard.

CENSUS REPORT ON CENTRAL STATIONS.

The statistics relate to the years ending December 31, 1907, and June 30, 1902. The totals include central stations only. They do not include isolated plants or plants that were idle or in course of construction, and in but few instances plants operated by electric railway companies.

	1907.	1902.	Per cent of increase.
Number of establishments	4,714	3,620	30.2
Commercial	3,462	2,805	23.4
Municipal	1,252	815	53.6
Total cost of plants	$996,613,622	$504,740,352	97.5
Total income (1)	$175,642,338	$85,700,605	104.9
Lighting service	$125,755,114	$70,138,147	79.3
All other electrical service	$43,859,577	$14,048,458	212.2
All other sources	$6,027,647	$1,514,000	298.1
Total expenses	$134,196,911	$68,081,375	97.1
Salaried employees			
Number	12,990	6,996	85.7
Salaries	$11,733,727	$5,663,580	107.2
Wage earners:			
Average number	34,642	23,330	48.5
Wages	$23,686,537	$14,983,112	58.1
Supplies, materials and fuel	$44,458,568	$22,915,932	94.0
All other expenses (including interest on bonds)	$54,318,019	$24,518,751	121.5
Steam and gas engines (including turbines):			
Number	7,674	6,095	25.9
Horse-power	2,684,228	1,392,122	92.8
Water wheels:			
Number	2,474	1,390	78.0
Horse-power	1,347,487	438,472	207.3
Total kw capacity of dynamos	2,642,403	1,218,735	116.8
Output of stations, total kw hrs.	5,858,121,860	2,507,051,115	133.7
Estimated number of lamps wired for service:			
Arc lamps (2)	555,921	385,698	44.1
Incandescent lamps (2)	41,807,944	18,194,044	129.8
Stationary motors served:			
Total horse-power capacity	1,649,026	438,005	276.5

(1) Exclusive of income for current used for light and power that was furnished by railway companies, and which is included in the report for street and electric railways.

(2) Exclusive of lamps used by the establishments reporting to light their own properties.

The final report will contain an analysis of the above totals and present detail statistics by States and for other phases of the industry.

CENSUS REPORT ON STREET ELECTRIC RAILWAYS.

The totals include reports of operating and lessor companies and a considerable number of electric light plants operated in connection with electric railways, but do not include reports of railways under construction during the census years; nor do they include reports of financing companies which were not engaged in actual operation of railways or light plants.

	1907.	1902.	per cent of increase.
Number of operating and lessor companies	1,236	987	25.2
Length of line (first main track), miles	25,547	16,652	53.4
Total length of single track, miles	34,404	22,577	52.4
Number of cars, total	83,641	66,784	25.2
Passenger	70,016	60,290	16.1
All other	13,625	6,494	109.8
Number of power houses	827	805	2.7
Steam and gas engines (inc. turbines) number	2,552	2,351	8.5
Horsepower	2,384,518	1,300,058	83.4
Water wheels, number	228	160	42.5
Horse-power	91,961	49,303	86.5
Total kw. capacity of dynamos	1,727,030	898,362	92.2
Output of stations, total kw hrs.	4,759,130,100	2,261,484,397	110.4
Passengers carried, total	9,533,080,766	5,836,615,296	63.3
Fare	7,441,114,508	4,774,211,904	55.9
Transfer	1,995,658,101	1,062,403,392	87.8
Free	96,308,157	(1)	....
Total car mileage (passenger, express, freight, etc.)	1,618,343,584	1,144,430,466	41.4
Condensed income account, operating companies:			
Earnings from operation	$418,187,858	$247,553,999	68.9
Income from other sources, (2)	11,556,396	2,950,628	291.7
Gross income	$429,744,254	$250,504,627	71.6
Operating expenses	$251,309,252	$142,312,597	76.6
Net earnings (earnings less operating expenses)	$166,878,606	$105,241,402	58.6
Gross income less operating expenses	$178,435,002	$108,192,030	64.9
Deductions from income (taxes and fixed charges)	$138,094,716	$77,595,053	78.0
Net income	$40,340,286	$30,596,977	31.8
Dividends (operating companies only)	$25,558,857	$15,882,110	60.9
Surplus	$14,781,429	$14,714,867	0.5
Capitalization, operating and lessor companies:			
Capital stock authorized, par value	$2,508,054,336	$1,529,199,589	64.0
Capital stock outstanding, par value	$2,097,708,856	$1,315,572,960	59.5
Dividends on stock	$53,589,399	$33,039,171	62.2
Bonds authorized, par value	$2,319,220,837	$1,341,429,727	72.9
Bonds outstanding, par value	$1,677,063,240	$992,709,139	68.9
Interest on bonds	$71,468,788	$43,578,961	64.0
Total par value stock and bonds outstanding	(3) $3,774,772,096	$2,308,282,099	63.5
Employees and wages, operating companies:			
Salaried employees, number	11,700	7,128	64.1
Salaries	$12,909,466	$7,439,716	73.5
Wage-earners, average Number	209,729	133,641	56.9
Wages	$138,081,633	$80,770,449	71.0

(1) Not reported separately.

(2) Includes $3,255,618 income from interest on bonds and dividends on stock of other electric railways.

(3) Includes permanent and other investments, such as securities of other electric railways, treasury stocks and bonds, gas plants, etc.: 1907—$388,394,092. 1902—$152,513,997.

The final report for 1907 will contain an analysis of the above totals and present detail statistics for other phases of the industry.

ELECTRIC RAILWAYS IN CALIFORNIA.

Compiled by the Journal of Electricity, Power and Gas.

Company.	Mileage.	Connects.
Bakersfield & Kern Elec. Ry. Co	7.5 miles	Bakersfield and Kern.
Northern Electric Ry. Co.	134 "	Barber, Chico, Marysville, Oroville and Sacramento.
San Diego Electric Ry Co.	34 "	San Diego.
Coronado Railway Co.	2.09 "	San Diego and Coronado.
National City & Otay Ry. Co.	28 "	San Diego, National City and Chula Vista.
Los Angeles & San Diego Ry. Co.	17 "	San Diego, La Jolla, Pacific Beach and Old Town.
South Park & Eastside Ry. Co.	2.5 "	San Diego.
Humboldt Transit Co.	13 "	Eureka.
Fresno Traction Co.	15.5 "	Fresno.
Nevada County Traction Co.	5 "	Grass Valley and Nevada City.
Los Angeles Ry. Co.	134 "	Los Angeles.
Los Angeles Interurban Ry. Co.	67 "	Los Angeles.
Pacific Electric Ry.	215.5 "	Los Angeles and Suburbs.
Los Angeles Pacific Co.	210 "	Los Angeles and Suburbs.
Monterey & Pacific Grove Ry. Co.	6 "	Monterey and Suburbs.
Vallejo, Benecia & Napa Valley Ry. Co.	16 "	Vallejo and Napa.
San Francisco, Vallejo & Napa Valley Ry. Co.	19 "	Napa and St. Helena.
Oakland Traction Co.	162.26 "	Alameda Co. Towns.
S. F., Oakland & San Jose Co.'s Ry.	18.68 "	Alameda Co. Towns.
Ontario & San Antonio Heights Elec. Ry. Co.	10 "	Ontario.
Santa Clara Interurban Ry. Co.	10 "	Palo Alto.
Petaluma & Santa Rosa Ry. Co.	36 "	Petaluma, Santa Rosa, Sebastapool and Forestville.
Riverside & Arlington Ry. Co.	12.71 "	Riverside and Arlington.
Crescent City Ry. Co.	5 "	Riverside and Crestmore.
Sacramento Elec. Ry. & Gas Co.	28 "	Sacramento.
San Bernardino Valley Traction Co.	42 "	San Bernardino, Colton, Highland, Patton, Arrowhead and Redlands.
Northwestern Pacific Ry. Co.	16.02 "	Sausilito, Larkspur, Mill Valley, Ross, Fairfax, and San Rafael.
Ocean Shore Railroad Co.	4 "	San Francisco.
Parkside Transit Co.	6.75 "	San Francisco.
Presidio & Ferries Railroad Co.	7.63 "	San Francisco.
United Railroads of San Francisco	259 "	San Francisco.
San Jose Ry Co.	15 "	San Jose.
San Jose & Santa Clara Co. Ry. Co.	28 "	Santa Clara, San Jose, East San Jose, Alum Rock Park.
San Jose & Los Gatos Interurban Ry. Co.	40 "	San Jose, Campbell, Los Gatos and Saratoga.
Pacific Coast Ry. Co.	14 "	Santa Maria, Guadalupe and Betteravia.
Santa Barbara Consolidated Ry. Co.	10 "	Santa Barbara.
Union Traction Co.	15 "	Santa Cruz and Capitola.
Central California Traction Co.	29 "	Lodi and Stockton.
Stockton Railroad Co.	13 "	Stockton.
Visalia Railroad Co.	24 "	Visalia, Exeter and Lemon Cove.

NEWS NOTES

FINANCIAL.

SAN FRANCISCO, CAL.—The Northern California Power Company, Consolidated, has declared a dividend of 10 cents per share, payable January 22.

WILLOWS, CAL.—The Northern California Power Company has appealed from the decision of the Superior Court awarding Mrs. May Diller, of Chico, $30,000 damages for the death of her husband.

SUNNYVALE, CAL.—At the annual meeting of the stockholders of the Sunnyvale Water Company, the reports showed that the company had assets of $14,000. The following officers were elected for the ensuing year: W. E. Crossman, president; R. Muender, vice-president; F. B. Hughes, secretary and treasurer. The new board of directors includes: C. L. Stowell, W. E. Crossman, J. F. Spaulding, R. Muender and C. C. Spaulding.

SAN BERNARDINO, CAL.—A. G. Hubbard of Redlands, acting for the Cleveland Savings Bank and Trust Company, has deeded to the Bear Valley Mutual Water Company all of the water rights and other properties of the old Bear Valley Water Company for $1,234,533, and in return has received from the Bear Valley Mutual Water Company a trust deed covering all of this property to secure the payment of bonds to the amount of $900,000. This, it is believed finally adjusts the Bear Valley water rights questions, and places with the actual water users the irrigation project which included the construction of the Bear Valley dam many years ago.

INCORPORATIONS.

HANFORD, CAL.—Lake Oil Co., with a capital stock of $75,000, has been incorporated here by H. J. Light, C. H. Bailey, R. A. Moore, G. E. Chinn, and W. L. Scally.

SAN FRANCISCO, CAL.—Santa Rita Oil Co., with a capital stock of $100,000, has been incorporated in this city by H. H. Hart, J. C. R. Rudolph, J. H. Lewis, E. L. Firster and R. R. Moody.

SAN FRANCISCO, CAL.—Coalinga Star Oil Company, with a capital stock of $1,000,000 has been incorporated by C. S. Reynolds, P. Righetti, J. M. Byrne, John McMullen and J. H. Barnard.

MERCED, CAL.—The Dos Palos Telephone Company filed articles of incorporation last week. H. T. Reynolds, A. S. Woodhouse, and George Christien with 30 other persons are listed as shareholders.

SAN FRANCISCO, CAL.—The Clear Lake Northern Railway Company with a capital stock of $1,000,000, has been incorporated in this city by R. C. Burnett, R. M. Sims, Marion Vecki, W. I. Brobeck and E. Schwab.

SAN FRANCISCO, CAL.—The Oakland and Antioch Railway Company has been incorporated here with a capital stock of $2,000,000 by A. W. Maltby, S. L. Naphthaly, Walter Arnstein, F. W. Brooks, H. A. Mitchell, and Allan Pollak.

TRANSMISSION.

SANTA CRUZ, CAL.—Work has been begun on the excavation for the new electric power plant to be erected by the San Vincent Lumber Company at Moore's Gulch.

SAN FRANCISCO, CAL.— The Great Western Power Company has awarded a contract for 300 tons of steel to the American Bridge Company for a building in Oakland.

MAGALIA, CAL.—The power house of the Steifer mine was completely demolished by the rush of water after the dams above here collapsed last week. Only a part of the machinery now remains. The site will be immediately cleared and the plant restored.

RENO, NEV.—Rolla H. Clapp has appropriated 4,000 second feet from the Truckee River to be used for power purposes.

OAKLAND, CAL.—The San Francisco representatives of the Great Western Power Company have applied for a permit to construct a distributing plant on Sessions Basin. The building will be a reinforced concrete, fire proof structure and will cost $50,000.

CHICO, CAL.—At a meeting of the directors and stockholders of the Sierra Electric Power Company, held last week, the reports showed that poles have been cut, roads built, a telephone line constructed, canals dug and estimates and surveys made. Estimates on machinery are now being received. It is planned at first to develop 2,000 horse power and eventually to increase this to 6,000 horse power.

WALLACE, IDAHO.—Seven large dams will be constructed in the St. Joe river during the next two years by the Milwaukee, which, when completed, will be used to generate electric power that will run its trains through the mountain country. A company capitalized at $500,000 and known as the Idaho Water and Electric Power Company has been organized for the purpose. Plans have been drawn and all estimates made for the dams and active work will be started as soon as weather conditions will permit. The total cost of building these dams is estimated at about $300,0000 to $400,000.

DUNSMUIR, CAL. — The Siskiyou Electric Light and Power Company will extend its line from Montague to Dunsmuir, and install another 1,500-horsepower generator at Fall Creek. The equipment has already been ordered for the installation. The company expects to have the extension completed by June 1. Seven miles of the new power line is being installed along the Klamath River for the mines of that section. The company is now supplying power for light to Ashland, Oregon, and to Yreka, Montague, Aetna, Fort Jones, Klamathon, Lairds, Greenview, and Dunsmuir, in Northern California. The new extension will serve Gazelle, Edgewood, Weed, Sisson and Shasta Springs. The Siskiyou Electric Light and Power Company was recently re-incorporated for $1,000,000. Alex. J. Rosborough, of Oakland, is secretary.

TELEPHONE AND TELEGRAPH.

INDEPENDENCE, CAL.—A. T. Smith & Co. have been granted a telephone franchise in this county.

PLACERVILLE, CAL.—The petition of J. A. Fossati for the right to construct a telephone line along the old emigrant road has been filed.

CHICO, CAL.—The right to construct and operate a telephone line along a public highway of this county has been granted to J. H. Richardson.

LINCOLN, CAL. — The Farmer's Telephone Company west of Lincoln, has been granted permission to erect poles within the town limits for the construction of a line to the central office.

DIAMOND SPRINGS, CAL.—The Diamond Springs and Hawks Exchange Telephone Company has elected the following officers: W. W. Hoyt, chairman and W. S. Voss, secretary. W. W. Hoyt was chosen general manager of construction.

PORTLAND, ORE.—The Postal Telegraph Company has been awarded $66,600 damages against the Southern Pacific Company in its fight to compel the railroad company to give it a right of way along its tracks between Portland and California.

ILLUMINATING.

PETALUMA, CAL.—The charter of this city is to be amended to allow it to acquire a municipal gas plant.

ARTESIA, N. M.—A franchise has been granted to Oscar S. Coates to erect an electric light plant in this city.

SANTA ROSA, CAL. — The Board of Supervisors has sanctioned the purchase of a gas generating plant for the County Hospital at a cost not to exceed $450.

FAIRFIELD, CAL.—A franchise was granted last week to the Nixon-Kimmel Company to erect and operate an electric transmission system for heat, light and power purposes.

BAKERSFIELD, CAL.—The directors of the Kern Power, Transit and Light Company are considering plans for enlarging the power house and doubling the capacity of the plant.

NAPA, CAL.—A franchise was sold last week to H. D. N. Lehe, of Dixon, to construct and operate a surburban electric light and power line from this city to the Lake County border.

GRIDLEY, CAL.—A contract for the construction of a municipal pumping and lighting plant has been given to Richard Jenkins. The building will be 50 x 30 feet in size, brick with steel roof, fire proof, and will cost $2,027.

WOODLAND, CAL.—Because of a terrific wind and rain storm, last week, the electric light and power line was out of commission for three hours and communication with the outside world was cut off for the same length of time.

NORTH YAKIMA, WASH.—It is reported that Norman Brothers, owners of the Hotel Yakima and hotels in other cities will erect a large power plant in this city for the purpose of generating power for heat and lighting purposes.

RENO, NEV.—Because of high water and landslides, the several power plants that supply Reno, Carson and Virginia City with electric lights and power have all been out of commission, leaving those cities in darkness. All plants depending on electric power are closed.

LOS ANGELES, CAL.—The Edison Electric Company will spend half a million dollars in enlarging its gas plants in the towns surrounding Los Angeles. E. C. Jones of San Francisco, one of the foremost gas experts on the Coast, is now engaged in examining the works to ascertain their needs.

TACOMA, WASH.—It is proposed by the city council to build a steam power plant for use until the Nisqually river plant is completed and as an emergency plant afterward. The cost will be from $150,000 to $250,000, and voters will probably be called on to sanction the issuance of bonds at the spring election.

OIL.

BAKERSFIELD, CAL.—Ben A. Hayden has obtained the lease on the property of the Pioneer Oil Company in the Midway. He expects to begin drilling in 60 days.

VALLEJO, CAL.—The report is that the Standard Oil Company will establish a big refinery on the water front from which to supply the Napa Valley and Santa Rosa trade.

SAN LUIS OBISPO, CAL.—E. H. Smith and another interested partner, Mr. Grant, state that work on the construction of the plant of the California Petroleum Asphalt Company will begin soon and will be pushed as rapidly as possible.

SAN FRANCISCO, CAL.—The resignation is announced of John Baker, Jr., as second vice-president and general manager of the Union Oil Company. Donzel Stoney, a San Francisco attorney, is acting in Mr. Baker's place, and it is understood he will be formally elected next month.

LOS ANGELES, CAL.—The Canadian Pacific Oil Company is engaged in cleaning out its well No. 6, which became non-productive through clogging, and will soon have it in operation. They plan to sink a casing to the lowest stratum and materially increase the output of the company.

BAKERSFIELD, CAL.—Clarence J. Berry and Frank Kelley may combine all their interests, including the C. and J. Oil and Gold Company in McKittrick, under the name of the C. and J. Oil and Gold Company. Other properties that will be included are the hydraulic mining plant, installed in Alaska during the summer, and more than 1,500 acres of proven lands in different fields of the State.

TRANSPORTATION.

LOS ANGELES, CAL. — The Pacific Electric Railway Company has asked for an extension of time for the completion of its tracks in this city.

SPOKANE, WASH.—The Spokane and Inland Railroad have ordered nine 72-ton locomotives and a number of freight and passenger cars in the East; in addition, they are in the market for road material.

FRESNO, CAL.—The Supervisors have granted to the Fresno Traction Company a franchise for the extension of its Forthcamp line to the Wilson and North Fresno tracts. General Manager Wishon said he expected to have the line in operation by March 1st.

CHICO, CAL.—As a result of the storm the Northern Electric Company's Hamilton branch from here has received heavy damage, the tracks being washed out for several miles. The total damage to bridges and public works in Butte County will not be less than $250,000.

WATERWORKS.

HONOLULU.—Superintendent of the Public Works Marston Campbell has been taking up the question of a better water system for Hilo, with William Vanatta, the superintendent of the water system.

LOS ANGELES, CAL.—The Board of Public Works has asked for sealed bids for 60,000 feet of ½-inch galvanized iron water pipe with alternative bids to furnish the same in wrought iron galvanized pipe.

HONOLULU.—Hugh Howell, county engineer of Maui, has submitted his report showing that the preliminary surveys for the new pipe line, as suggested by Assistant Superintendent Kluegal, have been completed.

LOS ANGELES, CAL.—The Board of Public Works has announced that it will receive sealed bids for furnishing materials and supplies consisting of 1-inch and 2-inch black iron screw pipe in accordance with specifications.

MONROVIA, CAL.—It has been decided to replace the boilers at Chapman wells plant with tubular 125-horse power boilers of the type used by the government. Other improvements will include a new style air lift and compressor.

SANTA CRUZ, CAL.—C. B. Byrne estimates that it will take 2,200 feet of 8-foot pipe, 7,200 feet of 6-foot pipe, 17,775 feet of 4-foot pipe, and a total of 25,175 feet of water pipe needed for the East Side and for a portion of the West Side.

OAKLAND, CAL.—The Board of Public Works has recommended to the City Council an ordinance appropriating the necessary money for the building and machinery for a high pressure salt water fire system, contracts for which will be let about June 1st, so that the plant can be completed and placed in commission at the beginning of the next fiscal year.

LOS ANGELES, CAL.—The Long Beach Water Company announces that improvements to the extent of $25,000 will be made. Cast iron mains will be installed to take the place of wooden pipes now used. A large storage reservoir and electric pumping plant will be constructed, and pumping plants on the north side of Signal Hill will be re-adjusted. The Company will also build a storage reservoir on the old dam site north of the high pressure reservoir.